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2022 SOLVED PAPERS

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SESSION-1

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SOLVED PAPER

Held on
24th June, Morning Shift

JEE MAIN 2022

SECTION-A (MULTIPLE CHOICE QUESTIONS)

1. If a rocket runs on a fuel ($C_{15}H_{30}$) and liquid oxygen, the weight of oxygen required and CO_2 released for every litre of fuel respectively are
(Given : density of the fuel is 0.756 g/mL)
(a) 1188 g and 1296 g (b) 2376 g and 2592 g
(c) 2592 g and 2376 g (d) 3429 g and 3142 g

2. Consider the following pairs of electrons

(A) (i) $n = 3, l = 1, m_l = 1, m_s = +\frac{1}{2}$

(ii) $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$

(B) (i) $n = 3, l = 2, m_l = -2, m_s = -\frac{1}{2}$

(ii) $n = 3, l = 2, m_l = -1, m_s = -\frac{1}{2}$

(C) (i) $n = 4, l = 2, m_l = 2, m_s = +\frac{1}{2}$

(i) $n = 3, l = 2, m_l = 2, m_s = +\frac{1}{2}$

The pairs of electrons present in degenerate orbitals is/are
(a) only (A) (b) only (B)
(c) only (C) (d) (B) and (C).

3. Match List-I with List-II:

List-I	List-II
(A) $[PtCl_4]^{2-}$	(I) sp^3d
(B) BrF_5	(II) d^2sp^3
(C) PCl_5	(III) dsp^2
(D) $[Co(NH_3)_6]^{3+}$	(IV) sp^3d^2

Choose the most appropriate answer from the options given below.
(a) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)
(b) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(c) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(d) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

4. For a reaction at equilibrium

$$A_{(g)} \rightleftharpoons B_{(g)} + \frac{1}{2}C_{(g)}$$

the relation between dissociation constant (K), degree of dissociation (α) and equilibrium pressure (p) is given by

(a) $K = \dfrac{\alpha^{1/2}\, p^{3/2}}{\left(1+\frac{3}{2}\alpha\right)^{1/2}(1-\alpha)}$

(b) $K = \dfrac{\alpha^{3/2}\, p^{1/2}}{(2+\alpha)^{1/2}(1-\alpha)}$

(c) $K = \dfrac{(\alpha\, p)^{3/2}}{\left(1+\frac{3}{2}\alpha\right)^{1/2}(1-\alpha)}$

(d) $K = \dfrac{(\alpha\, p)^{3/2}}{(1+\alpha)(1-\alpha)^{1/2}}$

5. Given below are two statements :
Statement I : Emulsions of oil in water are unstable and sometimes they separate into two layers on standing.
Statement II : For stabilisation of an emulsion, excess of electrolyte is added.
In the light of above statements, choose the most appropriate answer from the options given below.
(a) Both Statement I and Statement II are correct.
(b) Statement I and Statement II are incorrect.
(c) Statement I is correct but Statement II is incorrect.
(d) Statement I is incorrect but Statement II is correct.

6. Given below are the oxides :
Na_2O, As_2O_3, N_2O, NO and Cl_2O_7
Number of amphoteric oxides is
(a) 0 (b) 1 (c) 2 (d) 3

7. Match List-I with List-II.

List-I	List-II
(A) Sphalerite	(I) $FeCO_3$
(B) Calamine	(II) PbS
(C) Galena	(III) $ZnCO_3$
(D) Siderite	(IV) ZnS

Choose the most appropriate answer from the options given below.
(a) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
(b) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
(c) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(d) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

8. The highest industrial consumption of molecular hydrogen is to produce compounds of element
(a) carbon (b) nitrogen
(c) oxygen (d) chlorine.

9. Which of the following statements are correct?
(A) Both LiCl and $MgCl_2$ are soluble in ethanol.
(B) The oxides Li_2O and MgO combine with excess of oxygen to give superoxide.
(C) LiF is less soluble in water than other alkali metal fluorides.
(D) Li_2O is more soluble in water than other alkali metal oxides.
Choose the most appropriate answer from the options given below.
(a) (A) and (C) only
(b) (A), (C) and (D) only
(c) (B) and (C) only
(d) (A) and (D) only

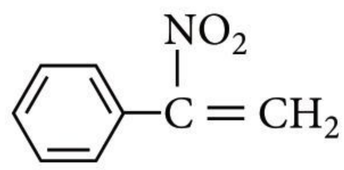
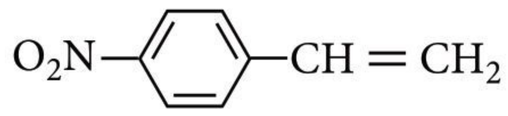
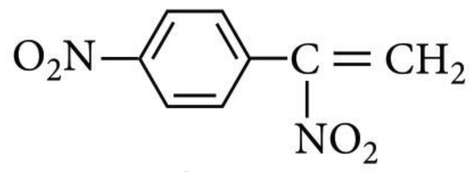
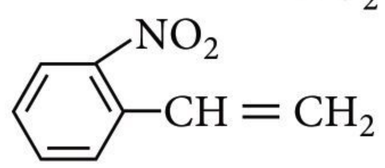
10. Identify the correct statement for B_2H_6 from those given below.
(A) In B_2H_6, all B-H bonds are equivalent.
(B) In B_2H_6, there are four 3-centre-2-electron bonds.
(C) B_2H_6 is a Lewis acid.
(D) B_2H_6 can be synthesised from both BF_3 and $NaBH_4$.
(E) B_2H_6 is a planar molecules.
Choose the most appropriate answer from the options given below.
(a) (A) and (E) only
(b) (B), (C) and (E) only
(c) (C) and (D) only
(d) (C) and (E) only

11. The most stable trihalide of nitrogen is
(a) NF_3 (b) NCl_3 (c) NBr_3 (d) NI_3

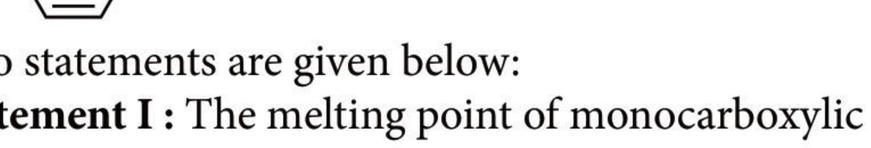
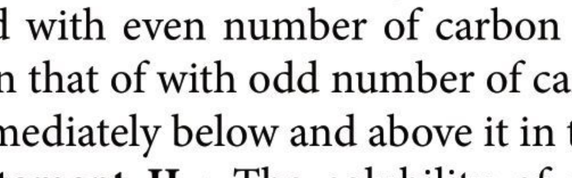
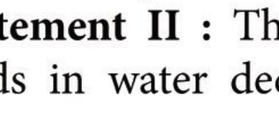
12. Which one of the following elemental forms is not present in the enamel of the teeth?
(a) Ca^{2+} (b) P^{3+} (c) F^- (d) P^{5+}

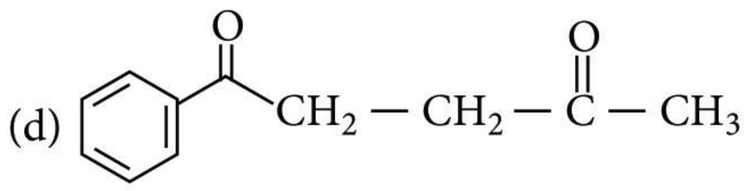
13. In the given reaction sequence, the major product '*C*' is

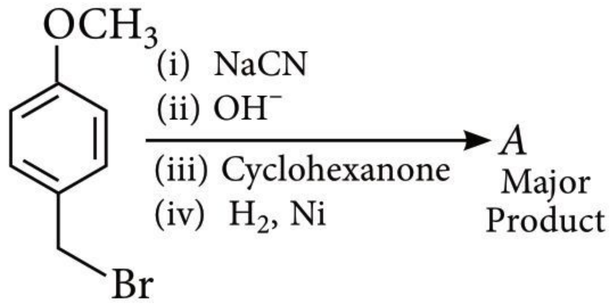
$$C_8H_{10} \xrightarrow[H_2SO_4]{HNO_3} A \xrightarrow[\Delta]{Br_2} B \xrightarrow[KOH]{\text{alcoholic}} C$$

(a) 
(b) 
(c) 
(d) 

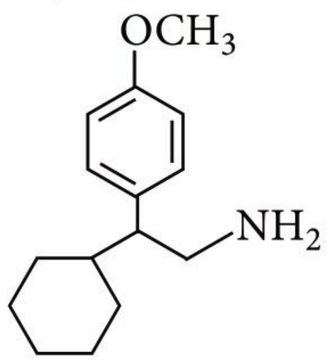
14. Two statements are given below:
Statement I : The melting point of monocarboxylic acid with even number of carbon atoms is higher than that of with odd number of carbon atoms acid immediately below and above it in the series.
Statement II : The solubility of monocarboxylic acids in water decreases with increase in molar mass.
Choose the most appropriate option.
(a) Both Statement I and Statement II are correct.
(b) Both Statement I and Statement II are incorrect.
(c) Statement I is correct but Statement II is incorrect.
(d) Statement I is incorrect but Statement II is correct.

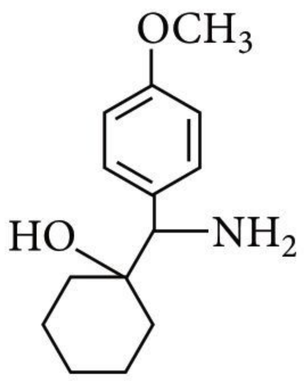
15. Which of the following is an example of conjugated diketone?
(a) 
(b) 
(c) 

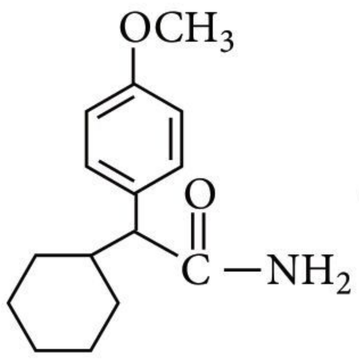
(d) 

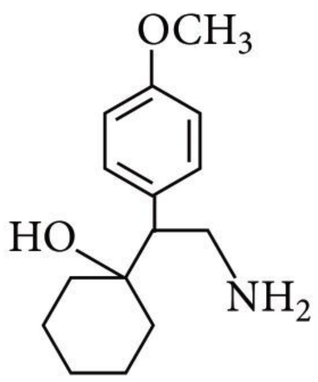
16. 

The major product of the above reaction is

(a) 

(b) 

(c) 

(d) 

17. Which of the following is an example of polyester?
(a) Butadiene-styrene copolymer
(b) Melamine polymer
(c) Neoprene
(d) Poly-β-hydroxybutyrate-co-β-hydroxyvalerate

18. A polysaccharide '*X*' on boiling with dil.H_2SO_4 at 393 K under 2-3 atm pressure yields '*Y*'. '*Y*' on treatment with bromine water gives gluconic acid. '*X*' contains β-glycosidic linkages only. Compound '*X*' is
(a) starch (b) cellulose
(c) amylose (d) amylopectin.

19. Which of the following is not a broad spectrum antibiotic?
(a) Vancomycin (b) Ampicillin
(c) Ofloxacin (d) Penicillin G

20. During the qualitative analysis of salt with cation y^{2+}, addition of a reagent (*X*) to alkaline solution of the salt gives a bright red precipitate. The reagent (*X*) and the cation (y^{2+}) present respectively are
(a) Dimethylglyoxime and Ni^{2+}
(b) Dimethylglyoxime and Co^{2+}
(c) Nessler's reagent and Hg^{2+}
(d) Nessler's reagent and Ni^{2+}

SECTION-B (NUMERICAL TYPE QUESTIONS)

Attempt any 5 questions out of 10.

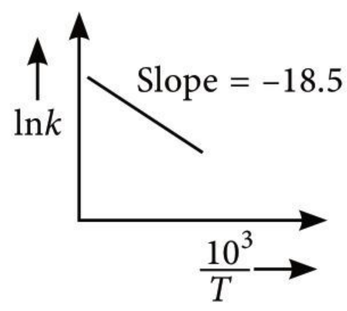
21. Atoms of element *X* form *hcp* lattice and those of element *Y* occupy $\frac{2}{3}$ of its tetrahedral voids. The percentage of element *X* in the lattice is _____. (Nearest integer)

22. $2O_{3(g)} \rightleftharpoons 3O_{2(g)}$
At 300 K, ozone is fifty percent dissociated. The standard free energy change at this temperature and 1 atm pressure is (–) _____ J mol^{-1}.
(Nearest integer)
(Given : ln 1.35 = 0.3 and R = 8.3 J K^{-1} mol^{-1})

23. The osmotic pressure of blood is 7.47 bar at 300 K. To inject glucose to a patient intravenously, it has to be isotonic with blood. The concentration of glucose solution in g L^{-1} is _____. (Nearest integer)
(Molar mass of glucose = 180 g mol^{-1}
R = 0.083 L bar K^{-1} mol^{-1})

24. The cell potential for the following cell
$Pt|H_{2(g)}|\ H^+_{(aq)}||\ Cu^{2+}(0.01\ M)|\ Cu_{(s)}$ is 0.576 V at 298 K. The pH of the solution is _____.
(Nearest integer)
(Given : $E^\circ_{Cu^{2+}/Cu} = 0.34$ V and $\frac{2.303RT}{F} = 0.06$ V)

25. The rate constants for decomposition of acetaldehyde have been measured over the temperature range 700-1000 K. The data has been analysed by plotting ln k *vs* $\frac{10^3}{T}$ graph.
The value of activation energy for the reaction is _____ kJ mol^{-1}.
(Nearest integer)
(Given : R = 8.31 J K^{-1} mol^{-1})



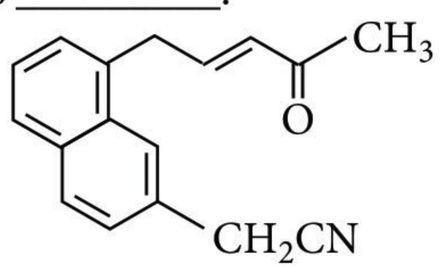
26. The difference in oxidation state of chromium in chromate and dichromate salts is _____.

27. In the cobalt-carbonyl complex : $[Co_2(CO)_8]$, number of Co-Co-bonds is "*X*" and terminal CO ligands is "*Y*". $X + Y$ = _____.

28. A 0.166 g sample of an organic compound was digested with conc. H_2SO_4 and then distilled with NaOH. The ammonia gas evolved was passed through 50.0 mL of 0.5 N H_2SO_4. The used acid

required 30.0 mL of 0.25 N NaOH for complete neutralization. The mass percentage of nitrogen in the organic compound is _____.

29. Number of electrophilic centres in the given compound is _____.



30. The major product '*A*' of the following given reaction has _____ sp^2 hybridized carbon atoms.

2,7-Dimethyl-2,6-octadiene $\xrightarrow{H^+}$ *A*
Major product

SOLUTIONS

1. (c): $C_{15}H_{30} + \frac{45}{2}O_2 \longrightarrow 15CO_2 + 15H_2O$

For 1 mole of $C_{15}H_{30}$, $\frac{45}{2}$ moles of $O_{2(g)}$ is required and 15 moles of $CO_{2(g)}$ has been released.

As the density of $C_{15}H_{30}$ is 0.756 g/mL,
hence 1 L or 1000 mL contains 756 g of $C_{15}H_{30}$.

Moles of $C_{15}H_{30} = \frac{756}{210} = 3.6$ moles

1 mol of $C_{15}H_{30}$ required $\frac{45}{2}$ mol of O_2.

So, 3.6 moles of $C_{15}H_{30}$ required $\frac{45}{2} \times 3.6$ mol of O_2.

Mass of O_2 required $= \frac{45}{2} \times 3.6 \times 32 = 2592$ g

Moles of CO_2 released = 15×3.6 mol

Mass of CO_2 released = $15 \times 3.6 \times 44 = 2376$ g

2. (b): *A* has 3*p* and 3*d* electrons.
B has both 3*d* electrons.
C has 4*d* and 3*d* electrons.
As *B* has both electrons from 3*d*-orbital so these are from degenerate orbitals.

3. (b):

$[PtCl_4]^{2-}$	dsp^2
BrF_5	sp^3d^2
PCl_5	sp^3d
$[Co(NH_3)_6]^{3+}$	d^2sp^3

4. (b)

5. (c): For stabilisation of an emulsion, emulsifying agents that are usually added are proteins, gums etc.

6. (b):

Acidic oxide	Cl_2O_7
Basic oxide	Na_2O
Neutral oxide	NO, N_2O
Amphoteric oxide	As_2O_3

7. (a):

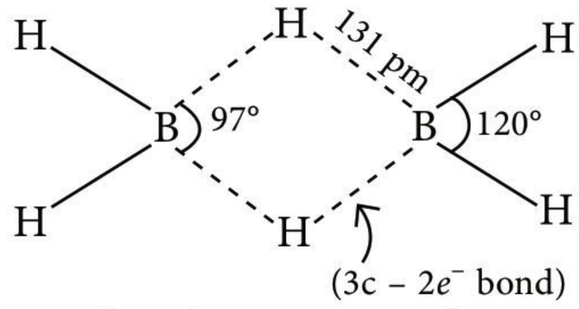
Sphalerite	ZnS
Calamine	$ZnCO_3$
Galena	PbS
Siderite	$FeCO_3$

8. (b): The highest industrial consumption of molecular hydrogen is in the synthesis of ammonia (compound of nitrogen) which is used in the manufacture of nitrogenous fertilizers.

$N_2 + 3H_2 \longrightarrow 2NH_3$

9. (a): LiCl and $MgCl_2$ are soluble in ethanol due to their polar nature and covalent character.
Li_2O and MgO do not form superoxide.
LiF is least soluble in water as compared to other alkali metal fluorides.
Li_2O has very high lattice enthalpy hence it is less soluble as compared to other alkali metal oxides.

10. (c):



All B—H bonds are not equal in B_2H_6.

Preparation of B_2H_6 :

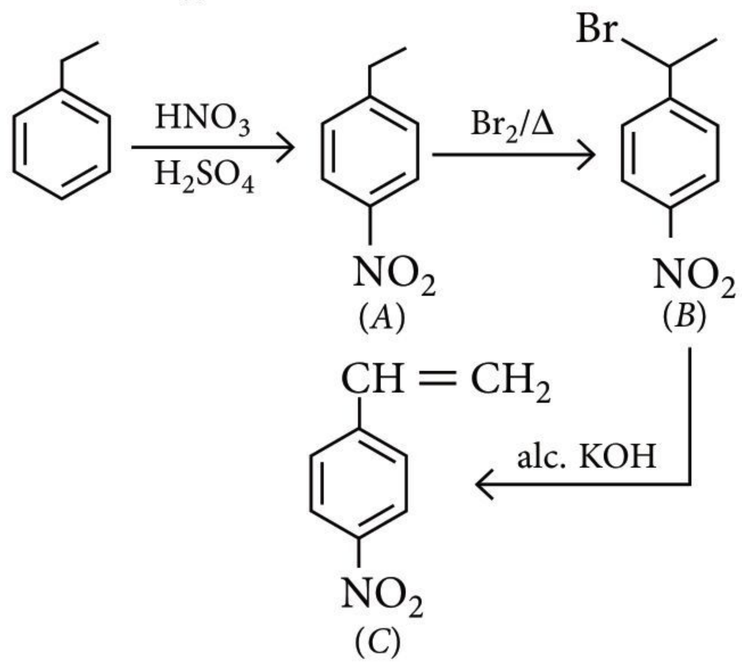
$3NaBH_4 + 4BF_3 \xrightarrow[450\ K]{ether} 3NaBF_4 + 2B_2H_6$

It is a Lewis acid.

11. (a): NF_3 is the only halide of nitrogen that is stable due to 2*p*–2*p* overlapping so, there is better overlapping.

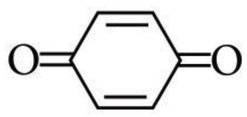
12. (b): Enamel is comprised of the phosphate mineral $[3Ca_3(PO_4)_2 \cdot CaF_2]$ which contains Ca^{2+}, P^{5+} and F^-. P^{3+} is not present in the enamel of the teeth

13. (b):



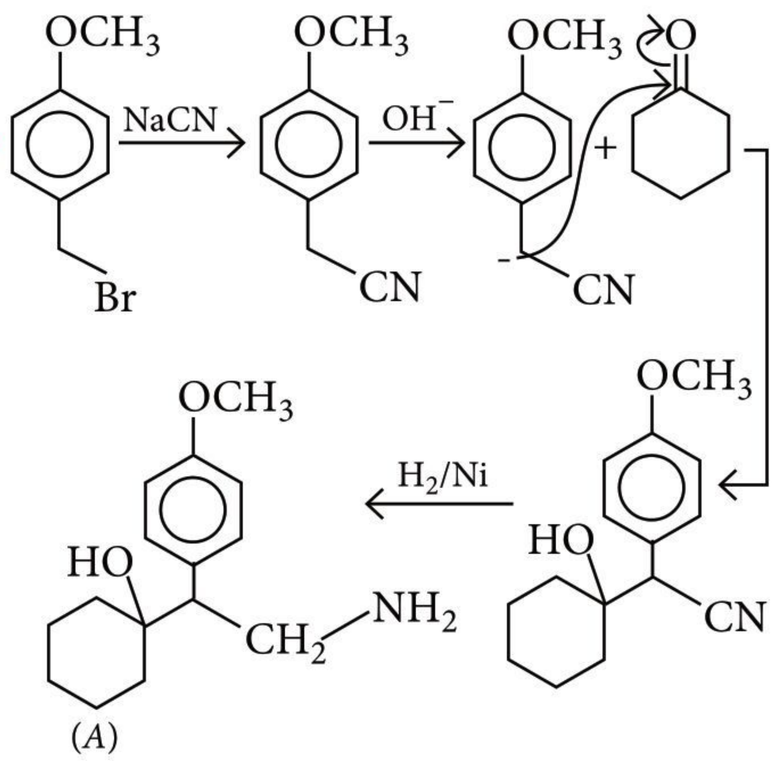
14. (a) : Melting points of carboxylic acids having even number of carbon atoms are greater than odd number as the carboxylic acids fit into the crystal lattice more strongly. Hence they have higher melting points and solubility decreases with increase in molecular mass as hydrocarbon part is hydrophobic in nature.

15. (c) : Conjugated means alternate single and double bonds.

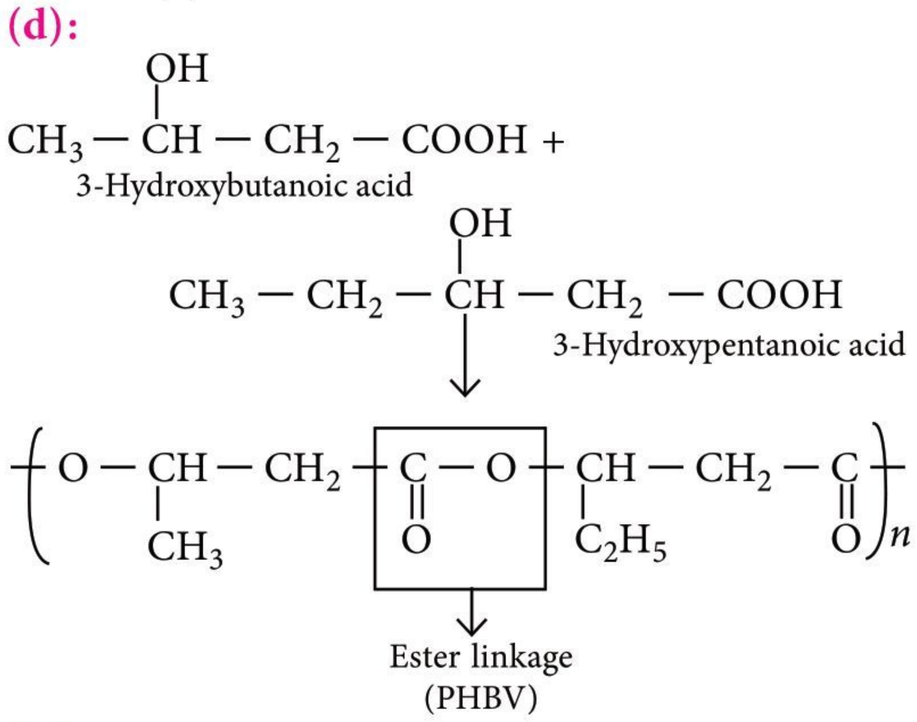


it has alternate double and single bonds.

16. (d):



17. (d):



18. (b): Glucose gives gluconic acid with treatment with Br_2 water hence, *Y* is glucose.
Cellulose is a polymer of β-*D*-glucose containing 1,4-glycosidic linkage. So, *X* is cellulose.

19. (d): The antibiotic which are effective over a wide range of both gram-positive and gram-negative bacteria are called broad spectrum antibiotics. For example, chloramphenicol, vancomycin, ofloxacin, ampicillin, etc.

For the SCIENTIST in YOU

Polymers for a sustainable environment and green energy!!

There is a worldwide race to find cleaner ways to supply the energy needs for modern life. One promising technology known as polymer electrolyte membrane fuel cells (PEMFC) is currently limited by degradation and cracking of the membrane electrodes. Their sensitivity to water vapour is the major challenge. Recently, researchers from China examined how the problem is caused by repetitive humidity changes, rather than simply by water itself.

PEMFC systems combine hydrogen fuel with oxygen to generate electrical energy, releasing water as the only end product. The hydrogen can be generated by splitting water into hydrogen and oxygen. That initial step requires energy, but great progress is being made in powering it with solar or other renewable energy sources.

Existing PEMFC systems rely on membrane electrodes built from synthetic polymers and carbon-based support material carrying metal catalysts. The catalysts promote the removal of electrons from hydrogen molecules. These electrons are channeled through the external circuit, powering any attached appliance. Hydrogen ions (H^+) produced by the removal of electrons from hydrogen molecules are transferred through the electrodes and membrane, eventually recombining with electrons and oxygen from the air, forming water.

The polymer part of the combined membrane and catalyst assembly has a mixture of electrically neutral regions and electrically charged – "ionised" – groups attached to the molecular backbone. This forms a structure called an ionomer.

The key problem causing degradation of the membranous catalyst layers is the formation and spread of cracks as the fuel cells run through cycles of activity. This has been appreciated for some time, but the mechanisms behind the problem have been unclear.

The research team examined the effect of changes in humidity and temperature on the performance of a PEMFC system. Such changes are likely to occur during the routine operation of a PEMFC as it cycles through periods of operation and times being switched off or on standby. The studies revealed that cycling between low and high temperatures accompanied by low and high humidity promotes the formation and spread of cracks. Crucially, they also found that undesirable relocation of the ionomers plays a key role in membrane degradation. This migration and aggregation of ionomer molecules encourages pre-existing and beneficial small voids in the structure to grow into larger and more damaging cracks.

So the degradation of the catalyst layer is related to ionomer migration induced by humidity changes," says one of the researchers.

Having identified a major reason behind the problematic cracking, the next challenge is to find ways to avoid it.

The researchers themselves suggest searching for modified ionomers that display a consistent level of water retention at different humidity levels. This would be expected to avoid the changes in water content that presumably drive the ionomer migration that itself leads to cracking.

20. (a) : Ni^{2+} gives red colour with dimethyl glyoxime (DMG).

$$Ni^{2+} + DMG \longrightarrow [Ni(DMG)_2]$$

Red coloured ppt.

21. (43) : Number of atoms in *hcp* unit cell = 6

So, X atoms = 6

Number of tetrahedral voids = $2 \times N = 2 \times 6 = 12$

$$Y \text{ atoms} = \frac{2}{3} \times 12 = 8$$

Formula is X_6Y_8 or X_3Y_4

$$\text{Percentage of } X = \frac{3}{7} \times 100 = 42.86\% \approx 43\%$$

22. (747) :

$$2O_{3(g)} \rightleftharpoons 3O_{2(g)}$$

Initial moles	1	0
At equilibrium = 0.5 mol	1–0.5 =0.75 mol	$\frac{3}{2} \times 0.5$

$$P_{O_3} = \frac{0.5}{1.25} \times P = \frac{2}{5};\ P_{O_2} = \frac{0.75}{1.25} \times P = \frac{3}{5};$$

(as P = 1 atm)

$$K_P = \frac{(P_{O_2})^3}{(P_{O_3})^2} = \frac{\left(\frac{3}{5}\right)^3}{\left(\frac{2}{5}\right)^2} = \frac{27}{20} = 1.35$$

$$\Delta G^\circ = -RT \ln k_p = -8.3 \times 300 \ln 1.35$$

$$= -8.3 \times 300 \times 0.3 = -747 \text{ J/mol}$$

23. (54) : π = 7.47 bar

π_{blood} should be = 7.47 bar

$\pi = CRT$

$$C = \frac{\pi}{RT} = \frac{7.47}{0.083 \times 300} = 0.3 \text{ mol/L}$$

Concentration in g/L = $0.3 \times 180 = 54$ g/L

24. (5) : Reaction of the given cell can be written as :

$$H_{2(g)} + Cu^{2+}_{(aq)} \rightarrow 2H^+_{(aq)} + Cu_{(s)}$$

According to Nernst equation

$$E_{cell} = E^\circ_{cell} - \frac{0.06}{n} \log \frac{[H^+]^2}{[Cu^{2+}]}$$

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 0.34 - 0 = 0.34 \text{ V}$$

$$E_{cell} = 0.34 - \frac{0.06}{2} \log \frac{[H^+]^2}{0.01}$$

$$0.576 - 0.34 = -0.03 \log \frac{[H^+]^2}{0.01}$$

$$\frac{0.236}{0.03} = -\log \frac{[H^+]^2}{0.01}$$

$$7.87 = -2 \log[H^+] + \log 0.01$$

$$7.87 = 2 \text{ pH} - 2$$

$$2 \text{ pH} = 9.87 \Rightarrow \text{pH} = 4.935 \approx 5$$

25. (154) : According to Arrhenius equation

$$k = Ae^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{RT}$$

For plot $\ln k$ *vs* $\frac{1}{T}$; Slope = $-E_a/R$

But for plot between $\ln k$ and $10^3/T$

$$\text{Slope} = \frac{-E_a}{1000R} = -18.5$$

$$E_a = 18.5 \times 8.31 \times 1000 = 154 \text{ kJ}$$

26. (0) : Chromate ion, CrO_4^{2-} ;

Let the oxidation state of Cr be x.

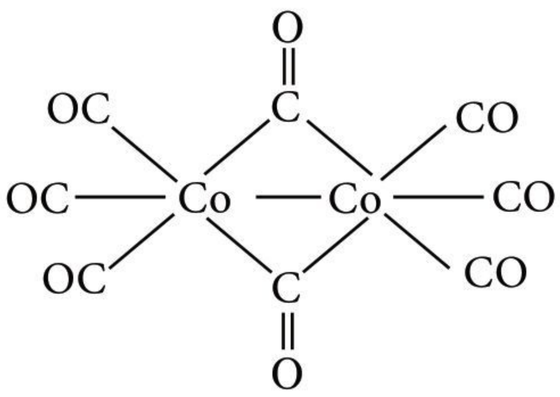
Then $x + 4(-2) = -2 \Rightarrow x = +6$

Dichromate ion, $Cr_2O_7^{2-}$;

Then, $2x + 7(-2) = -2 \Rightarrow x = +6$

So, difference in their oxidation state is zero.

27. (7) :



Number of Co — Co bond (X) = 1

Number of terminal CO bonds (Y) = 6

$\therefore \quad X + Y = 7$

28. (63) : Given :

Organic compound + conc. H_2SO_4 $\xrightarrow{\text{Distilled with NaOH}}$ NH_3

NH_3 $\xleftarrow{\text{Pass through}}$ 50 mL of 0.5 N H_2SO_4

Complete neutralization with 30 mL of 0.25 N NaOH

Milli eq. of NH_3 = Milli. eq. of conc. H_2SO_4 used

= Milli eq. of NaOH

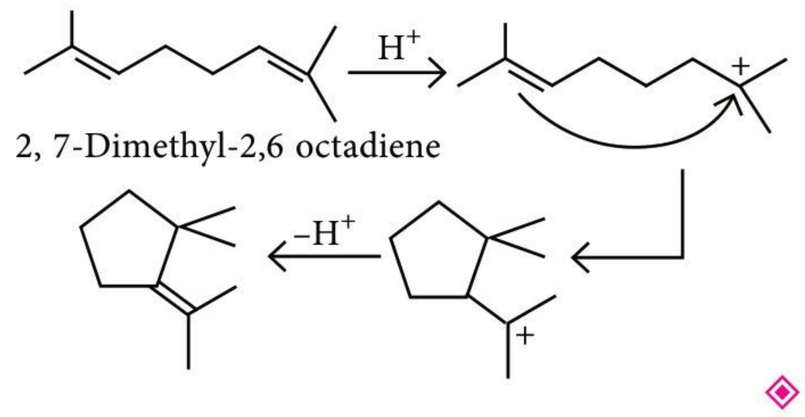
$= 30 \times 0.25 = 7.5$

Gram of nitrogen = $7.5 \times 14 \times 10^{-3} = 0.105$ g

$$\% \text{ of nitrogen} = \frac{0.105}{0.166} \times 100 = 63.25\%$$

29. (3)

30. (2) :



NEET

Exam Held on 17th July

SOLVED PAPER 2022

Hurray!! We are happy to inform our readers that out of the 50 questions asked in NEET 2022, more than 90% questions were either exactly same or of similar type from the **MTG Books.** Hurray!!

Here, the references of few are given :

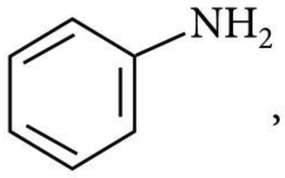
Exam Q. No.	MTG Book	Q. No.	P. No.
2	NEET Champion (XI)	1	44
8	NCERT Fingertips (XI)	70	236
9	NCERT Fingertips (XII)	34	371
12	NEET Champion (XII)	56	96
13	NEET Champion (XII)	92	127
15	NCERT Fingertips (XI)	10	239
17	34 Years (XII)	15	76
18	NCERT Fingertips (XI)	1	156
20	NEET Champion (XI)	182	260
21	NEET Champion (XI)	161	233
22	NEET Champion (XII)	35	95
24	NEET Champion (XI)	187	66
28	NCERT Fingertips (XII)	64	83
30	NEET Guide (XII)	125	366
32	NCERT Fingertips (XI)	50	102
33	NEET Guide (XII)	17	455
45	NEET Guide (XII)	4	26
47	NEET Guide (XI)	80	40
48	NEET Guide (XII)	176	254

and more such questions .....

SECTION - A

1. Identify the incorrect statement from the following.
(a) Alkali metals react with water to form their hydroxides.
(b) The oxidation number of K in KO_2 is +4.
(c) Ionisation enthalpy of alkali metals decreases from top to bottom in the group.
(d) Lithium is the strongest reducing agent among the alkali metals.

2. The IUPAC name of an element with atomic number 119 is
(a) ununennium (b) unnilennium
(c) unununnium (d) ununoctium.

3. Which of the following is suitable to synthesize chlorobenzene?
(a) Benzene, Cl_2, anhydrous $AlCl_3$
(b) Phenol, $NaNO_2$, HCl, CuCl
(c)  , HCl
(d)  , HCl, heating

4. Match List-I with List-II.

List-I		List-II	
(A)	Li	(i)	absorbent for carbon dioxide
(B)	Na	(ii)	electrochemical cells
(C)	KOH	(iii)	coolant in fast breeder reactors
(D)	Cs	(iv)	photoelectric cell

Choose the correct answer from the options given below:
(a) (A) -(iv), (B) - (i), (C) - (iii), (D) - (ii)
(b) (A) -(iii), (B) - (iv), (C) - (ii), (D) - (i)
(c) (A) -(i), (B) - (iii), (C) - (iv), (D) - (ii)
(d) (A) -(ii), (B) - (iii), (C) - (i), (D) - (iv)

5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : ICl is more reactive than I_2.
Reason (R) : I — Cl bond is weaker than I — I bond.

In the light of the above statements, choose the most appropriate answer from the options given below:

(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is not correct but (R) is correct.

6. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : In a particular point defect, an ionic solid is electrically neutral, even if few of its cations are missing from its unit cell.

Reason (R) : In an ionic solid, Frenkel defect arises due to dislocation of cation from its lattice site to interstitial site, maintaining overall electrical neutrality.

In the light of the above statements, choose the most appropriate answer from the options given below:

(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is not correct but (R) is correct.

7. Given below are two statements:

Statement-I : The boiling points of aldehydes and ketones are higher than hydrocarbons of comparable molecular masses because of weak molecular association in aldehydes and ketones due to dipole-dipole interactions.

Statement-II : The boiling points of aldehydes and ketones are lower than the alcohols of similar molecular masses due to the absence of H-bonding.

In the light of the above statements, choose the most appropriate answer from the options given below:

(a) Both statement-I and statement-II are correct.
(b) Both statement-I and statement-II are incorrect.
(c) Statement-I is correct but statement-II is incorrect.
(d) Statement-I is incorrect but statement-II is correct.

8. Choose the correct statement.

(a) Diamond and graphite have two dimensional network.
(b) Diamond is covalent and graphite is ionic.
(c) Diamond is sp^3 hybridised and graphite is sp^2 hybridised.
(d) Both diamond and graphite are used as lubricants.

9. Match List-I with List-II.

List-I (Drug class)		**List-II (Drug molecule)**	
(A)	Antacids	(i)	Salvarsan
(B)	Antihistamines	(ii)	Morphine
(C)	Analgesics	(iii)	Cimetidine
(D)	Antimicrobials	(iv)	Seldane

Choose the correct answer from the options given below:

(a) (A) -(iii), (B) - (ii), (C) - (iv), (D) - (i)
(b) (A) -(iii), (B) - (iv), (C) - (ii), (D) - (i)
(c) (A) -(i), (B) - (iv), (C) - (ii), (D) - (iii)
(d) (A) -(iv), (B) - (iii), (C) - (i), (D) - (ii)

10. Match List-I with List-II.

List-I (Products formed)		**List-II (Reaction of carbonyl compound with)**	
(A)	Cyanohydrin	(i)	NH_2OH
(B)	Acetal	(ii)	RNH_2
(C)	Schiff's base	(iii)	Alcohol
(D)	Oxime	(iv)	HCN

Choose the correct answer from the options given below:

(a) (A) -(iii), (B) - (iv), (C) - (ii), (D) - (i)
(b) (A) -(ii), (B) - (iii), (C) - (iv), (D) - (i)
(c) (A) -(i), (B) - (iii), (C) - (ii), (D) - (iv)
(d) (A) -(iv), (B) - (iii), (C) - (ii), (D) - (i)

11. Given below are two statements:

Statement-I : Primary aliphatic amines react with HNO_2 to give unstable diazonium salts.

Statement-II : Primary aromatic amines react with HNO_2 to form diazonium salts which are stable even above 300 K.

In the light of the above statements, choose the most appropriate answer from the options given below:

(a) Both statement-I and statement-II are correct.
(b) Both statement-I and statement-II are incorrect.

(c) Statement-I is correct but statement-II is incorrect.
(d) Statement-I is incorrect but statement-II is correct.

12. Given below are two statements:
Statement-I : In the coagulation of a negative sol, the flocculating power of the three given ions is in the order : $Al^{3+} > Ba^{2+} > Na^{+}$.
Statement-II : In the coagulation of a positive sol, the flocculating power of the three given salts is in the order : $NaCl > Na_2SO_4 > Na_3PO_4$.
In the light of the above statements, choose the most appropriate answer from the options given below:
(a) Both statement-I and statement-II are correct.
(b) Both statement-I and statement-II are incorrect.
(c) Statement-I is correct but statement-II is incorrect.
(d) Statement-I is incorrect but statement-II is correct.

13. Given below are two statements:
Statement-I : The boiling points of the following hydrides of group 16 elements increases in the order:
$H_2O < H_2S < H_2Se < H_2Te$.
Statement-II : The boiling points of these hydrides increase with increase in molecular mass.
In the light of the above statements, choose the most appropriate answer from the options given below:
(a) Both statement-I and statement-II are correct.
(b) Both statement-I and statement-II are incorrect.
(c) Statement-I is correct but statement-II is incorrect.
(d) Statement-I is incorrect but statement-II is correct.

14. In one molal solution that contains 0.5 mole of a solute, there is
(a) 500 mL of solvent (b) 500 g of solvent
(c) 100 mL of solvent (d) 1000 g of solvent.

15. Which of the following statements is not correct about diborane?
(a) There are two 3-centre-2-electron bonds.
(b) The four terminal B – H bonds are two centre two electron bonds.
(c) The four terminal hydrogen atoms and the two boron atoms lie in one plane.
(d) Both the boron atoms are sp^2 hybridised.

16. Match List-I with List-II.

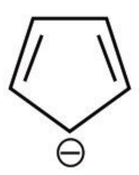
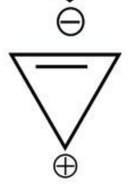
List-I (Hydrides)		**List-II (Nature)**	
(A)	MgH_2	(i)	Electron precise
(B)	GeH_4	(ii)	Electron deficient
(C)	B_2H_6	(iii)	Electron rich
(D)	HF	(iv)	Ionic

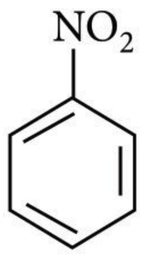
Choose the correct answer from the options given below:
(a) (A) -(iv), (B) - (i), (C) - (ii), (D) - (iii)
(b) (A) -(iii), (B) - (i), (C) - (ii), (D) - (iv)
(c) (A) -(i), (B) - (ii), (C) - (iv), (D) - (iii)
(d) (A) -(ii), (B) - (iii), (C) - (iv), (D) - (i)

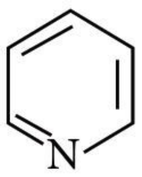
17. The incorrect statement regarding chirality is
(a) S_N1 reaction yields 1 : 1 mixture of both enantiomers
(b) the product obtained by S_N2 reaction of haloalkane having chirality at the reactive site shows inversion of configuration
(c) enantiomers are superimposable mirror images of each other
(d) a racemic mixture shows zero optical rotation.

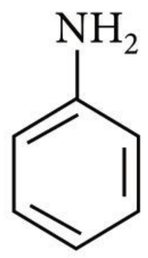
18. The pH of the solution containing 50 mL each of 0.10 M sodium acetate and 0.01 M acetic acid is
[Given : pK_a of CH_3COOH = 4.57]
(a) 5.57 (b) 3.57 (c) 4.57 (d) 2.57

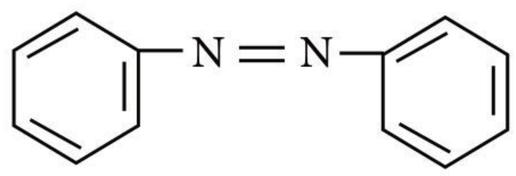
19. The IUPAC name of the complex $[Ag(H_2O)_2][Ag(CN)_2]$ is
(a) dicyanidosilver(II) diaquaargentate(II)
(b) diaquasilver(II)dicyanidoargentate(II)
(c) dicyanidosilver(I) diaquaargentate(I)
(d) diaquasilver(I)dicyanidoargentate(I).

20. Which compound amongst the following is not an aromatic compound?
(a) 
(b) 
(c) 
(d) 

21. The Kjeldahl's method for the estimation of nitrogen can be used to estimate the amount of nitrogen in which one of the following compounds?
(a) 

(b) 

(c) 

(d) 

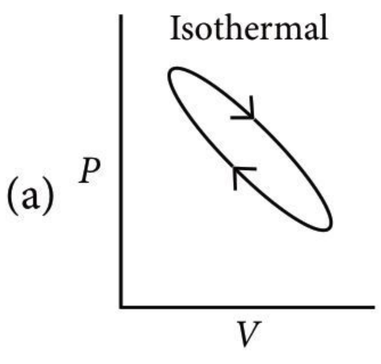
22. The incorrect statement regarding enzymes is
    (a) enzymes are biocatalysts
    (b) like chemical catalysts enzymes reduce the activation energy of bio processes
    (c) enzymes are polysaccharides
    (d) enzymes are very specific for a particular reaction and substrate.

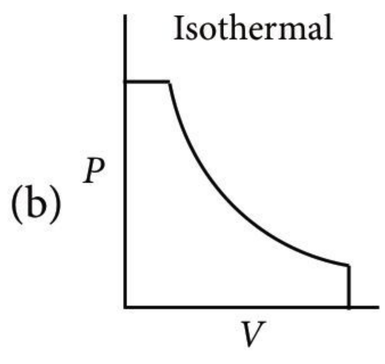
23. Gadolinium has a low value of third ionisation enthalpy because of
    (a) small size
    (b) high exchange enthalpy
    (c) high electronegativity
    (d) high basic character.

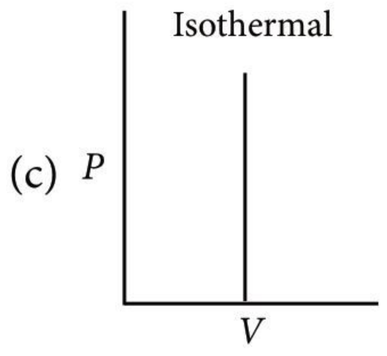
24. Which amongst the following is incorrect statement?
    (a) The bond orders of O_2^+, O_2, O_2^- and O_2^{2-} are 2.5, 2, 1.5 and 1, respectively.
    (b) C_2 molecule has four electrons in its two degenerate π molecular orbitals.
    (c) H_2^+ ion has one electron.
    (d) O_2^+ ion is diamagnetic.

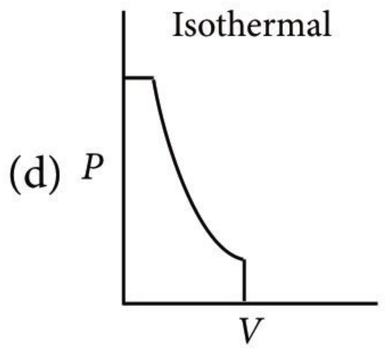
25. Given below are half-cell reactions:
    $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$;
    $E^\circ_{Mn^{2+}/MnO_4^-} = -1.510$ V
    $\frac{1}{2}O_2 + 2H^+ + 2e^- \longrightarrow H_2O$; $E^\circ_{O_2/H_2O} = +1.223$ V
    Will the permanganate ion, MnO_4^- liberate O_2 from water in the presence of an acid?
    (a) Yes, because $E^\circ_{cell} = +0.287$ V
    (b) No, because $E^\circ_{cell} = -0.287$ V
    (c) Yes, because $E^\circ_{cell} = +2.733$ V
    (d) No, because $E^\circ_{cell} = -2.733$ V

26. Which of the following *P*-*V* curve represents maximum work done?

(a) 

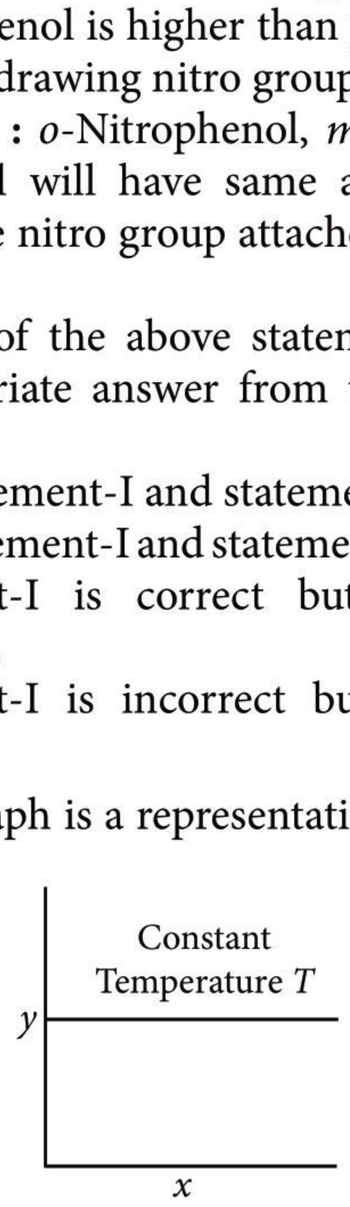
(b) 

(c) 

(d) 

27. Given below are two statements:
    Statement-I : The acidic strength of monosubstituted nitrophenol is higher than phenol because of electron withdrawing nitro group.
    Statement-II : *o*-Nitrophenol, *m*-nitrophenol and *p*-nitrophenol will have same acidic strength as they have one nitro group attached to the phenolic ring.
    In the light of the above statements, choose the most appropriate answer from the options given below:
    (a) Both statement-I and statement-II are correct.
    (b) Both statement-I and statement-II are incorrect.
    (c) Statement-I is correct but statement-II is incorrect.
    (d) Statement-I is incorrect but statement-II is correct.

28. The given graph is a representation of kinetics of a reaction.



    The *y* and *x* axes for zero and first order reactions, respectively are
    (a) zero order (y = concentration and x = time), first order ($y = t_{1/2}$ and x = concentration)
    (b) zero order (y = concentration and x = time), first order (y = rate constant and x = concentration)
    (c) zero order (y = rate and x = concentration), first order ($y = t_{1/2}$ and x = concentration)
    (d) zero order (y = rate and x = concentration), first order (y = rate and $x = t_{1/2}$)

29. Identify the incorrect statement from the following.
    (a) All the five 5*d* orbitals are different in size when compared to the respective 4*d* orbitals.
    (b) All the five 4*d* orbitals have shapes similar to the respective 3*d* orbitals.
    (c) In an atom, all the five 3*d* orbitals are equal in energy in free state.
    (d) The shapes of d_{xy}, d_{yz} and d_{zx} orbitals similar to each other; and $d_{x^2-y^2}$ and d_{z^2} are similar to each other.

30. $RMgX + CO_2 \xrightarrow[\text{ether}]{\text{dry}} Y \xrightarrow{H_3O^+} RCOOH$

What is Y in the above reaction?

(a) $RCOO^-Mg^+X$ (b) $R_3CO^-Mg^+X$

(c) $RCOO^-X^+$ (d) $(RCOO)_2Mg$

31. Amongst the following which one will have maximum lone pair-lone pair electron repulsions?

(a) ClF_3 (b) IF_5 (c) SF_4 (d) XeF_2

32. Which one is not correct mathematical equation for Dalton's Law of partial pressure? Here p = total pressure of gaseous mixture

(a) $p = p_1 + p_2 + p_3$

(b) $p = n_1\frac{RT}{V} + n_2\frac{RT}{V} + n_3\frac{RT}{V}$

(c) $p_i = x_i p$, where p_i = partial pressure of i^{th} gas
x_i = mole fraction of i^{th} gas in gaseous mixture

(d) $p_i = x_i p_i^\circ$, where x_i = mole fraction of i^{th} gas in gaseous mixture, p_i° = pressure of i^{th} gas in pure state

33. Which statement regarding polymers is not correct?

(a) Elastomers have polymer chains held together by weak intermolecular forces.

(b) Fibres possess high tensile strength.

(c) Thermoplastic polymers are capable of repeatedly softening and hardening on heating and cooling respectively.

(d) Thermosetting polymers are reusable.

34. What mass of 95% pure $CaCO_3$ will be required to neutralise 50 mL of 0.5 M HCl solution according to the following reaction?

$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + 2H_2O_{(l)}$

(Calculate upto second place of decimal point.)

(a) 1.25 g (b) 1.32 g

(c) 3.65 g (d) 9.50 g

35. At 298 K the standard electrode potentials of Cu^{2+} / Cu, Zn^{2+}/ Zn, Fe^{2+}/ Fe and Ag^+/Ag are 0.34 V, –0.76 V, –0.44 V and 0.80 V respectively.

On the basis of standard electrode potential, predict which of the following reaction cannot occur?

(a) $CuSO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + Cu_{(s)}$

(b) $CuSO_{4(aq)} + Fe_{(s)} \longrightarrow FeSO_{4(aq)} + Cu_{(s)}$

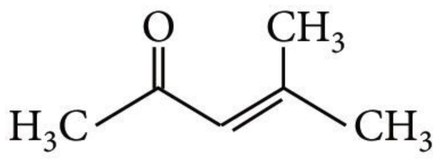
(c) $FeSO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + Fe_{(s)}$

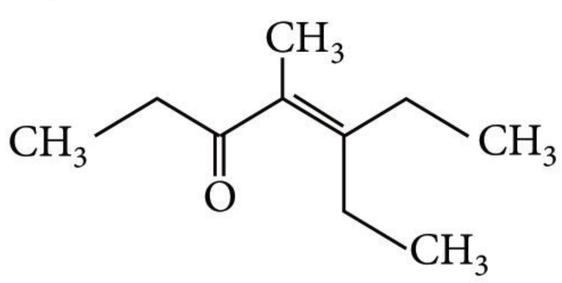
(d) $2CuSO_{4(aq)} + 2Ag_{(s)} \longrightarrow 2Cu_{(s)} + Ag_2SO_{4(aq)}$

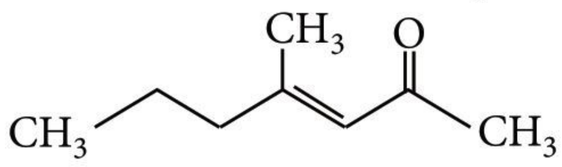
SECTION - B

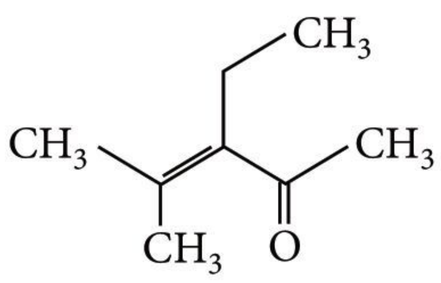
Attempt any 10 questions out of 15.

36. Which one of the following is not formed when acetone reacts with 2-pentanone in the presence of dilute NaOH followed by heating?

(a) 

(b) 

(c) 

(d) 

37. For a first order reaction $A \longrightarrow$ Products, initial concentration of A is 0.1 M, which becomes 0.001 M after 5 minutes. Rate constant for the reaction in min^{-1} is

(a) 1.3818 (b) 0.9212 (c) 0.4606 (d) 0.2303

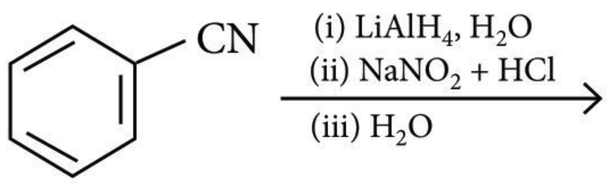
38. $3O_{2(g)} \rightleftharpoons 2O_{3(g)}$

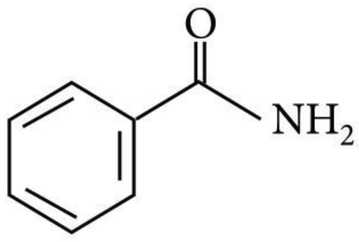
For the above reaction at 298 K, K_c is found to be 3.0×10^{-59}. If the concentration of O_2 at equilibrium is 0.040 M then concentration of O_3 in M is

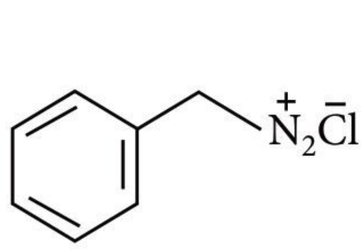
(a) 4.38×10^{-32} (b) 1.9×10^{-63}

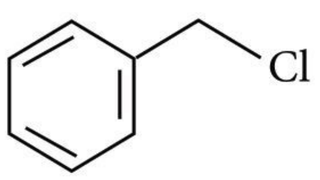
(c) 2.4×10^{31} (d) 1.2×10^{21}

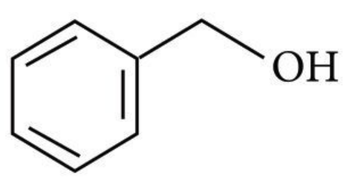
39. The product formed from the following reaction sequence is



(a) 

(b) 

(c) 

(d) 

40. Match List-I with List-II.

List -I (Ores)		List-II (Composition)	
(A)	Haematite	(i)	Fe_3O_4
(B)	Magnetite	(ii)	$ZnCO_3$
(C)	Calamine	(iii)	Fe_2O_3
(D)	Kaolinite	(iv)	$[Al_2(OH)_4Si_2O_5]$

Choose the correct answer from the options given below :

(a) (A) -(i), (B) -(ii), (C) -(iii), (D) -(iv)
(b) (A) -(iii), (B) -(i), (C) -(ii), (D) -(iv)
(c) (A) -(iii), (B) -(i), (C) -(iv), (D) -(ii)
(d) (A) -(i), (B) -(iii), (C) -(ii), (D) -(iv)

41. Given below are two statements :

Statement I : In Lucas test, primary, secondary and tertiary alcohols are distinguished on the basis of their reactivity with conc. HCl + $ZnCl_2$, known as Lucas Reagent.

Statement II : Primary alcohols are most reactive and immediately produced turbidity at room temperature on reaction with Lucas Reagent.

In the light of the above statements, choose the most appropriate answer from the options given below.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

42. Find the emf of the cell in which following reaction takes place at 298 K.

$Ni_{(s)} + 2Ag^+ (0.001\ M) \longrightarrow Ni^{2+} (0.001\ M) + 2Ag_{(s)}$

Given that $E^\circ_{cell} = 10.5$ V, $\frac{2.303RT}{F} = 0.059$ at 298 K)

(a) 1.0385 V (b) 1.385 V
(c) 0.9615 V (d) 1.05 V

43. Compound *X* on reaction with O_3 followed by Zn/H_2O gives formaldehyde and 2-methylpropanal as products. The compound *X* is

(a) 3-methylbut-1-ene (b) 2-methylbut-1-ene
(c) 2-methylbut-2-ene (d) pent-2-ene.

44. In the neutral or faintly alkaline medium $KMnO_4$ oxidises iodide into iodate. The change in oxidation state of manganese in this reaction is from

(a) +7 to +4 (b) +6 to +4
(c) +7 to +3 (d) +6 to +5

45. Copper crystallises in *fcc* unit cell with cell edge length of 3.608×10^{-8} cm. The density of copper is 8.92 g cm^{-3}. Calculate the atomic mass of copper.

(a) 63.1 u (b) 31.55 u
(c) 60 u (d) 65 u

46. A 10.0 L flask contains 64 g of oxygen at 27°C. (Assume O_2 gas is behaving ideally). The pressure inside the flask in bar is

(Given $R = 0.0831$ L bar K^{-1} mol^{-1})

(a) 2.5 (b) 498.6 (c) 49.8 (d) 4.9

47. If radius of second Bohr orbit of the He^+ ion is 105.8 pm, what is the radius of third Bohr orbit of Li^{2+} ion?

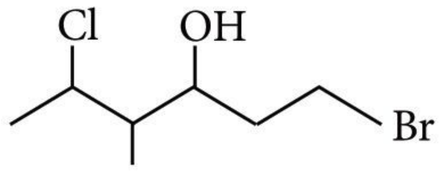
(a) 158.7 pm (b) 15.87 pm
(c) 1.587 pm (d) 158.7 Å

48. The order of energy absorbed which is responsible for the colour of complexes

(*A*) $[Ni(H_2O)_2(en)_2]^{2+}$
(*B*) $[Ni(H_2O)_4(en)]^{2+}$ and
(*C*) $[Ni(en)_3]^{2+}$
is

(a) (*A*) > (*B*) > (*C*) (b) (*C*) > (*B*) > (*A*)
(c) (*C*) > (*A*) > (*B*) (d) (*B*) > (*A*) > (*C*)

49. The correct IUPAC name of the following compound is



(a) 1-bromo-5-chloro-4-methylhexan-3-ol
(b) 6-bromo-2-chloro-4-methylhexan-4-ol
(c) 1-bromo-4-methyl-5-chlorohexan-3-ol
(d) 6-bromo-4-methyl-2-chlorohexan-4-ol.

50. The pollution due to oxides of sulphur gets enhanced due to the presence of

(*A*) particulate matter
(*B*) ozone
(*C*) hydrocarbons
(*D*) hydrogen peroxide

Choose the most appropriate answer from the options given below :

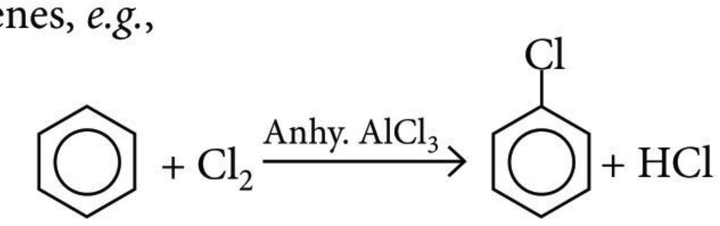
(a) (*A*), (*D*) only (b) (*A*), (*B*), (*D*) only
(c) (*B*), (*C*), (*D*) only (d) (*A*), (*C*), (*D*) only

SOLUTIONS

1. (b) : The superoxide species (KO_2) is represented as O_2^-, since the compound is neutral, therefore the oxidation state of potassium is +1. Remaining all the given statements are correct.

2. (a) : The IUPAC name of an element with atomic number 119 is ununennium.

3. (a) : Arenes react with halogens in the presence of a Lewis acid like anhydrous $FeCl_3$, $FeBr_3$ or $AlCl_3$ to yield haloarenes, *e.g.*,



4. (d) :

Element/Compound	Uses
Li	Electrochemical Cells
Na	Coolant in fast breeder reactors
KOH	Absorbent for carbon dioxide
Cs	Photoelectric cell

5. (a) : In general, interhalogen compounds are more reactive than halogens (except fluorine). This is because X–X' (ICl) bond in interhalogens is weaker than X–X (I–I) bond in halogens except F–F bond.

6. (b) : Frenkel defect is shown by ionic solids. The smaller ion (usually cation) is dislocated from its normal site to an interstitial site. It creates a vacancy defect at its original site and an interstitial defect at its new location.

7. (a) : Both the given statements are correct.

8. (c) : In diamond each carbon atom undergoes sp^3 hybridisation and linked to four other carbon atoms by using hybridised orbitals in tetrahedral fashion. In graphite, each carbon atom in hexagonal ring undergoes sp^2 hybridisation and make three sigma bonds with three neighbouring carbon atoms. Fourth electron forms a π-bond.

9. (b) : Antacids (A) - Cimetidine (iii)
Antihistamines (B) - Seldane (iv)
Analgesics (C) - Morphine (ii)
Antimicrobial (D) - Salvarsan (i)

10. (d) : Aldehydes react with HCN to give cyanohydrin.
Aldehydes react with alcohol to form acetal.
Aldehydes react with amine to give Schiff's base.
Aldehydes react with NH_2OH to give oxime.

11. (c) : Primary aliphatic amines react with nitrous acid to form aliphatic diazonium salts which are unstable while aromatic amines react with nitrous acid at low temperature (273-278 K) to form diazonium salts, a very important class of compounds used for synthesis of a variety of aromatic compounds.

12. (c) : In the coagulation of a positive sol, the flocculating power is in the order : $PO_4^{3-} > SO_4^{2-} > Cl^-$
or, $NaCl < Na_2SO_4 < Na_3PO_4$

13. (b) :

	H_2O	H_2S	H_2Se	H_2Te
B.pt. :	373 K	213 K	232 K	269 K

14. (b) : Molality (m) = $\frac{\text{Number of moles of solute}}{\text{Mass of solvent in kg}}$
Let amount of solvent be x g.

$$1 = \frac{0.5}{\frac{x}{1000}} \; ; x = 500 \text{ g}$$

15. (d) : In diborane (B_2H_6), each boron (B) atom uses sp^3 hybrid orbitals for bonding.

16. (a) : MgH_2 - Ionic hydride
GeH_4 - Electron precise hydride
B_2H_6 - Electron deficient hydride
HF - Electron rich hydride

17. (c) : Enantiomers are non-superimposable mirror images of each other. Enantiomers possess identical physical properties namely, melting point, boiling point, refractive index, etc. They only differ with respect to the rotation of plane polarised light. If one of the enantiomer is dextrorotatory, then other will be laevorotatory.

18. (a) : It is an acidic buffer.
For acidic buffer,

$$\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]} = 4.57 + \log \frac{0.1}{0.01}$$

$$= 4.57 + \log 10 = 4.57 + 1 = 5.57$$

19. (d)

20. (d) : Compound (d) is not an aromatic compound as reflected by the non planarity of the methylene bridge (—CH_2—) with respect to other atoms. However, tropylium cation is aromatic due to planarity.

21. (c) : Kjeldahl method is not applicable to compounds containing nitrogen in nitro group, azo groups and nitrogen present in the ring (*e.g.*, pyridine).

22. (c) : Enzymes are protein molecules of high molecular mass and form colloidal solutions in water.

23. (b) : Due to high exchange enthalpy, $Gd^{3+}(4f^7)$ acquires extra stability and has low third ionisation enthalpy.

24. (d) : $O_2^+ : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \ \pi 2p_x^2 = \pi 2p_y^2 \ \pi^* 2p_x^1$

Due to the presence of one unpaired electron, O_2^+ is paramagnetic in nature.

25. (a) : $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$= 1.510 - 1.223 = +0.287$

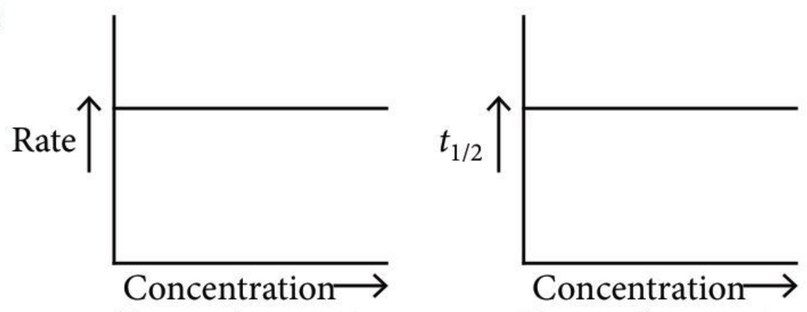
As E°_{cell} is positive, hence the reaction is feasible.

26. (b)

27. (c) : Electron withdrawing groups (*e.g.*, $-NO_2$) stabilise the phenoxide ion more by dispersing the negative charge relative to phenol (i.e. release of proton becomes easy) and thus, increase the acidic strength of phenols. The particular effect is more when the substituent is present on *o*- and *p*-positions than in *m*-position to the phenolic group. Thus, acidic strength of nitrophenols decreases in the order :

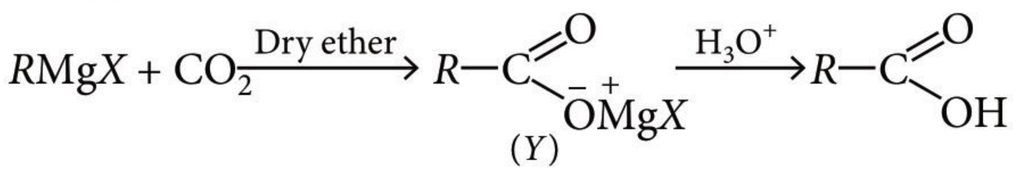
p-nitrophenol > *o*-nitrophenol > *m*-nitrophenol > phenol.

28. (c) :



29. (d) : The shapes of d_{xy}, d_{yz}, d_{xz} and $d_{x^2-y^2}$ are similar to each other, whereas that of d_{z^2} is different from others. All five 3*d*-orbitals are equivalent in energy. The *d*-orbitals for which *n* is greater than 3 (4*d*, 5*d*, ...) also have shapes similar to 3*d*-orbital but differ in energy and size.

30. (a) :



31. (d) : ClF_3, IF_5, SF_4 and XeF_2 contain 2, 1, 1 and 3 lone pairs of electrons on the central atom respectively. Hence, XeF_2 has maximum lone pair-lone pair repulsions.

32. (d)

33. (d) : Thermosetting polymers on heating undergoes extensive cross-linking and becomes infusible. Hence, these cannot be reused.

34. (b) : Volume of HCl = 50 mL = 0.05 L

Molarity of HCl = 0.5 M

$\therefore$ Moles of HCl = $0.05 \times 0.5 = 0.025$ moles

$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

For 2 moles of HCl, $CaCO_3$ required = 1 mole

$\therefore$ For 0.025 moles of HCl, $CaCO_3$ required

$= \frac{0.025}{2}$ moles

Mass of $CaCO_3$ required = $100 \times \frac{0.025}{2} = 1.25$ g

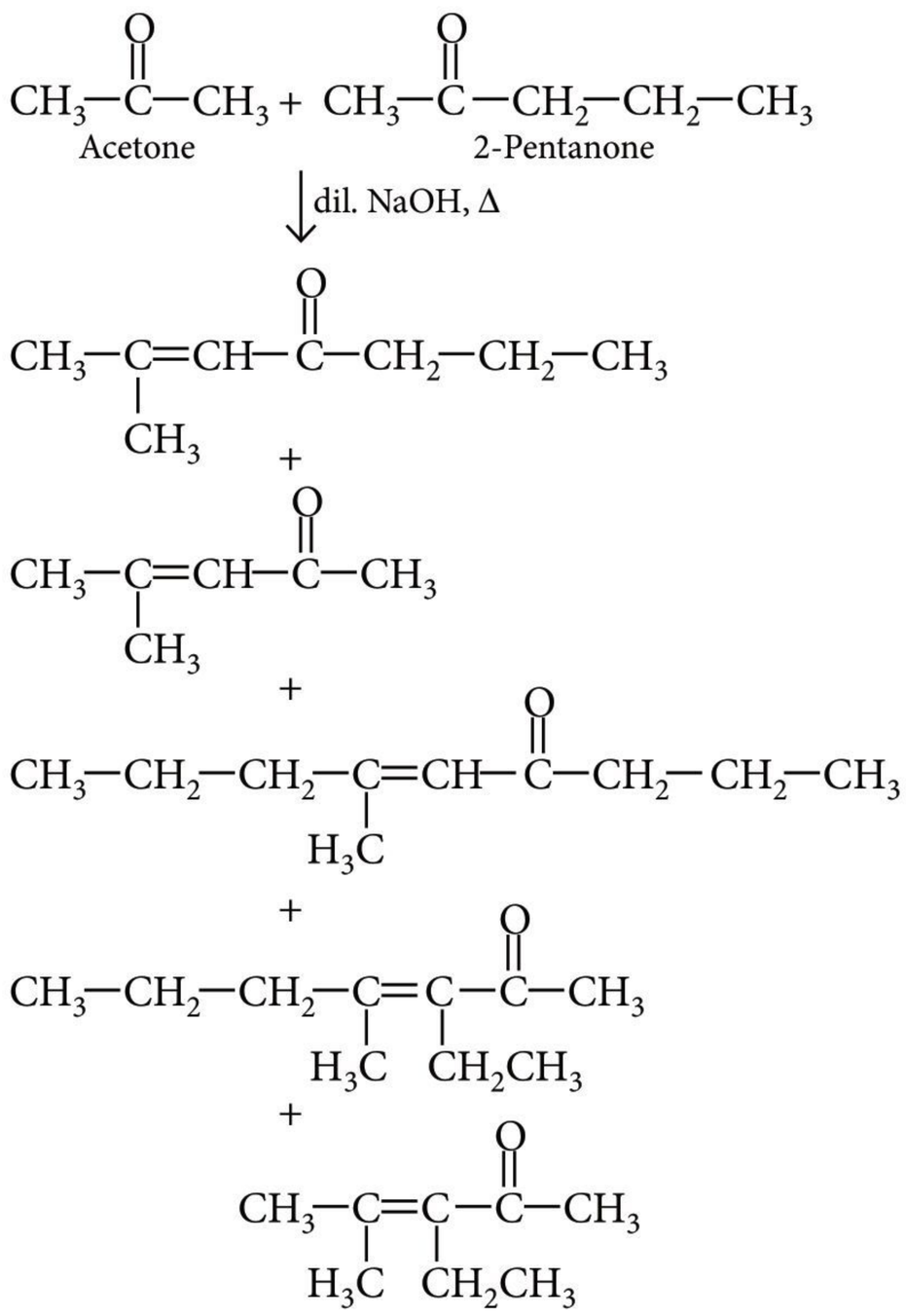
For 95% pure $CaCO_3$, mass of $CaCO_3$ required

$= \frac{1.25}{95} \times 100 \text{ g} = 1.315 \text{ g} \approx 1.32$ g

35. (d) : The values of standard reduction potential of Cu and Ag suggest that Cu would undergo oxidation (lower reduction potential) and Ag would undergoes reduction (higher reduction potential). Hence, the feasible cell reaction will be

$$Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag$$

36. (b) : When acetone reacts with 2-pentanone in the presence of dil. NaOH, following products are formed:



37. (b) : For a first order reaction,

$$k = \frac{2.303}{t} \log\left(\frac{a}{a-x}\right) ; \ k = \frac{2.303}{5} \log\left(\frac{0.1}{0.001}\right)$$

$$k = \frac{2.303}{5} \log 10^2 = \frac{2.303 \times 2}{5} = 0.9212 \text{ min}^{-1}$$

38. (a) : $3O_{2(g)} \rightleftharpoons 2O_{3(g)}$

Initial conc.	1	0
At equilibrium	$1-3x$	$2x$

$$K_c = \frac{[O_3]^2}{[O_2]^3} = 3\times10^{-59}$$

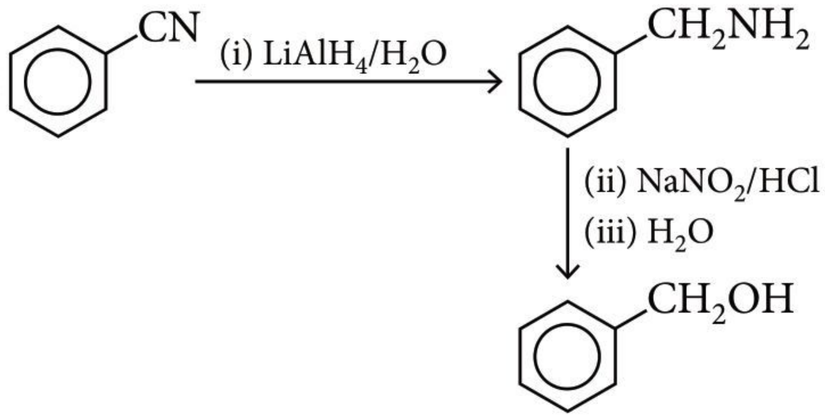
Given, $[O_2] = 0.040$ M

$$K_c = \frac{[O_3]^2}{(0.040)^3} = 3\times10^{-59}$$

$[O_3]^2 = 1.92 \times 10^{-63}$

$[O_3] = 4.38 \times 10^{-32}$ M

39. (d) :



40. (b) : Haematite - Fe_2O_3
Magnetite - Fe_3O_4
Calamine - $ZnCO_3$
Kaolinite - $Al_2O_3\cdot2SiO_2\cdot2H_2O$

41. (c) : Tertiary alcohols are most reactive and immediately produce turbidity at room temperature while primary alcohols do not react with Lucas reagent at room temperature.

42. (c) : According to Nernst equation,

$$E = E^\circ_{cell} - \frac{0.059}{n}\log\frac{[Ni^{2+}]}{[Ag^+]^2}$$

$E^\circ_{cell} = 1.05$ (Given)

Note : Please read 10.5 as 1.05 in question.

$$E = 1.05 - \frac{0.059}{2}\log\frac{(0.001)}{(0.001)^2}$$

$$= 1.05 - \frac{0.059}{2}\log10^3 = 1.05 - \frac{0.059\times3}{2}$$

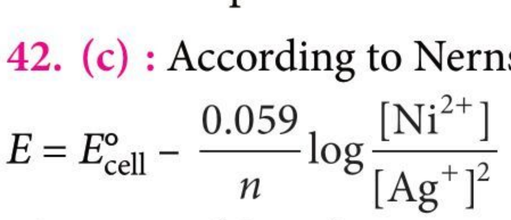
$= 1.05 - 0.0885 = 0.9615$ V

43. (a) : Given, $X + O_3 \xrightarrow{Zn/H_2O}$

$$HCHO + CH_3{-}CH(CH_3){-}CHO$$

Formaldehyde + 2-Methylpropanal

So, X can be



3-Methylbut-1-ene

44. (a) : Reaction of MnO_4^- with I^- in neutral or faintly alkaline solution :

$$2\overset{+7}{Mn}O_4^- + H_2O + \overset{-1}{I^-} \longrightarrow 2\overset{+4}{Mn}O_2 + 2OH^- + \overset{+5}{I}O_3^-$$

45. (a) : Density of unit cell, $d = \frac{Z\times M}{N_0\times a^3}$

Given, $a = 3.608 \times 10^{-8}$ cm

$d = 8.92$ g/cm^3

$Z = 4$ (for *fcc*)

$$M = \frac{N_0\times a^3\times d}{Z} = \frac{6.023\times10^{23}\times(3.608\times10^{-8})^3\times8.92}{4}$$

$= 63.08$ u ≈ 63.1 u

46. (d) : $V = 10$ L

Mass of $O_2 = 64$ g, $T = 300$ K

According to ideal gas equation, $PV = nRT$

$$P = \frac{nRT}{V} = \frac{64}{32}\times\frac{0.0831\times300}{10};\ P = 4.986 \text{ bar}$$

47. (a) : Radius $= r_0 \times \frac{n^2}{Z}$

For He^+, $n = 2$; $Z = 2$

$$r_{He^+} = r_0 \times \frac{2\times2}{2};\ 105.8 = r_0 \times 2$$

$$r_0 = \frac{105.8}{2}\text{ pm}$$

For Li^{2+}, $n = 3$; $Z = 3$

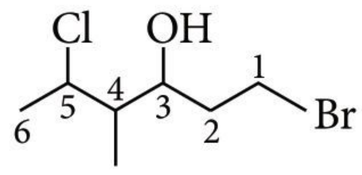
$$r_{Li^{2+}} = r_0 \times \frac{(3)^2}{3} = \frac{105.8}{2}\times3 = 158.7 \text{ pm or } 1.587 \text{ Å}$$

48. (c) : Chelating ligand increases the stability of complex compound and higher the number of chelating ligands, higher will be the stability. Higher is the strength of the ligand, higher is the amount of energy absorbed by the complex.

Hence, order is

$$\underset{(C)}{[Ni(en)_3]^{2+}} > \underset{(A)}{[Ni(H_2O)_2(en)_2]^{2+}} > \underset{(B)}{[Ni(H_2O)_4(en)]^{2+}}$$

49. (a) :



1-Bromo-5-chloro-4-methylhexan-3-ol

50. (b) : The presence of particulate matter in polluted air catalyses the oxidation of sulphur dioxide to sulphur trioxide.

$2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_{3(g)}$

The reaction can also be promoted by ozone and hydrogen peroxide.

$SO_{2(g)} + O_{3(g)} \rightarrow SO_{3(g)} + O_{2(g)}$

$SO_{2(g)} + H_2O_{2(l)} \rightarrow H_2SO_{4(aq)}$

JEE 2022 ADVANCED

PRACTICE PAPER

Exam on 28th August

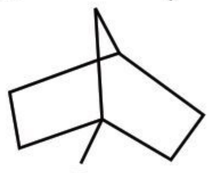
PAPER - I

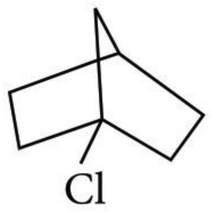
SECTION 1

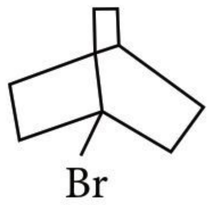
This section contains FOUR (04) questions.
Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer.
For each question, choose the correct option corresponding to the correct answer.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+3***	***If ONLY the correct option is chosen.***
Zero Marks :	***0***	***If none of the options is chosen (i.e., the question is unanswered).***
Negative Marks :	***–1***	***In all other cases.***

1. Which of the following halides will give fastest rate of S_N1 solvolysis.

(a) 

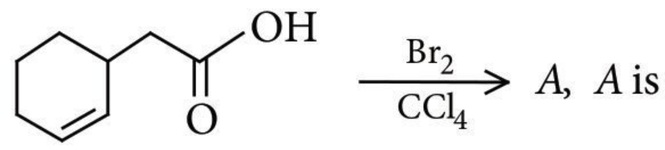
(b) 

(c) 

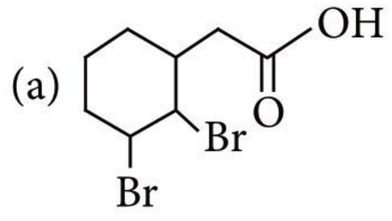
(d) All three have same rate of reaction.

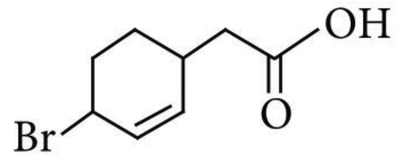
2. Matte contains
(a) Cu_2S, FeS and silica
(b) Cu_2S, Fe_2S_3 and silica
(c) Fe
(d) Cu_2S and silica.

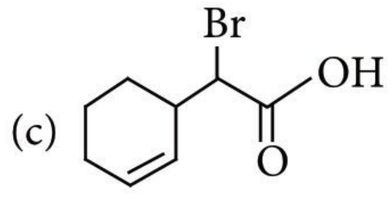
3. Inspite of being an odd-electron molecule, ClO_2 does not dimerize because
(a) the odd electron is delocalized
(b) the odd electron is localized in the chlorine atom
(c) the two Cl – O bonds do not have the same length
(d) of $p_x - p_x$ bonding in the chlorine atom.

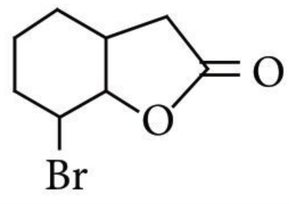
4. 

A, *A* is

(a) 

(b) 

(c) 

(d) 

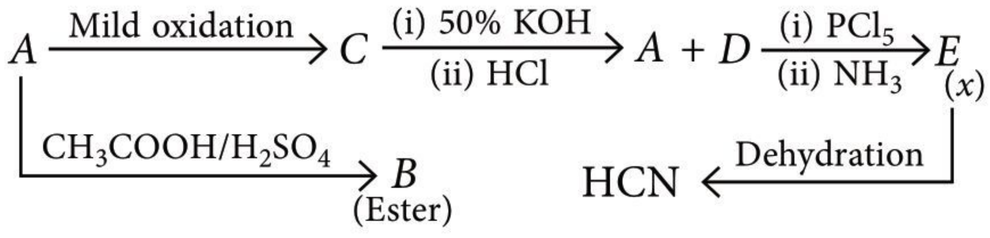
SECTION 2

This section contains THREE (03) question stems.
There are TWO (02) questions corresponding to each question stem.
The answer to each question is a NUMERICAL VALUE.
For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+2***	***If ONLY the correct numerical value is entered at the designated place***
Zero Marks :	***0***	***In all other cases.***

Question Stem for Question Nos. 5 and 6

Question Stem

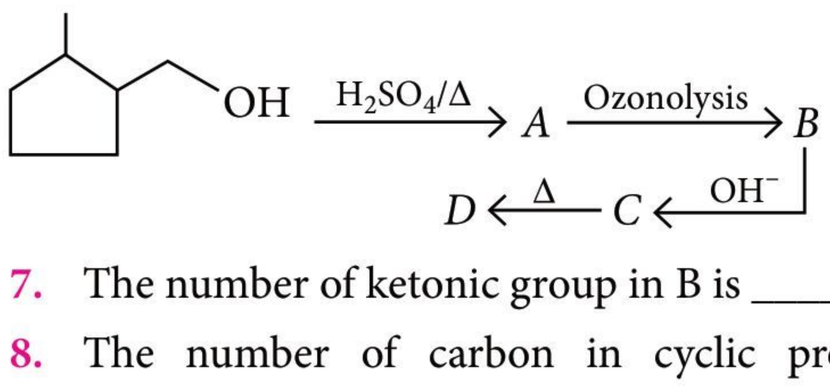


5. The molecular mass (in g mol^{-1}) of '*D*' is _____.

6. The number of hydrogen in '*A*' is _____.

Question Stem for Question Nos. 7 and 8

Question Stem



7. The number of ketonic group in B is _____.

8. The number of carbon in cyclic product 'B' is _____.

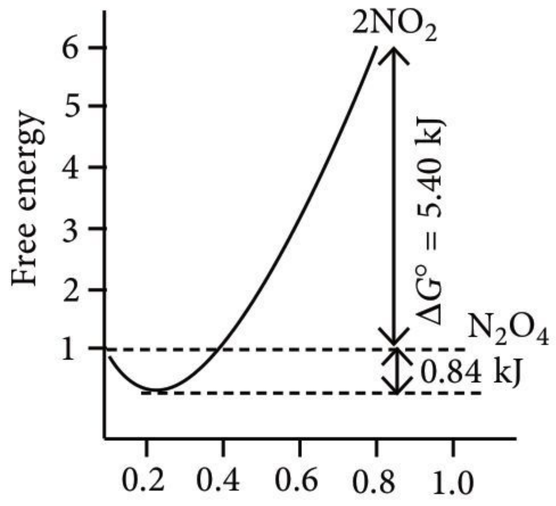
Question Stem for Question Nos. 9 and 10

Question Stem

Consider the following reaction

$$N_2O_{4(g)} \longrightarrow 2NO_{2(g)}$$

The free energy of the reaction occurring at 298 K and 1 atm has been plotted against the fraction of N_2O_4 dissociated as shown below:



9. When two moles of NO_2 change into equilibrium mixture with N_2O_4, the magnitude of ΔG° is _____.

10. When one mole of N_2O_4 change into equilibrium mixture with NO_2, the magnitude of ΔG° is _____.

SECTION 3

This section contains SIX (06) questions.
Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is (are) correct answer(s).
For each question, choose the option(s) corresponding to (all) the correct answer(s).
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+4***	***If only (all) the correct option(s) is(are) chosen;***
Partial Marks :	***+3***	***If all the four options are correct but ONLY three options are chosen;***
Partial Marks :	***+2***	***If three or more options are correct but ONLY two options are chosen, both of which are correct;***
Partial Marks :	***+1***	***If two or more options are correct but ONLY one option is chosen and it is a correct option;***
Zero Marks :	***0***	***If unanswered;***
Negative Marks :	***−2***	***In all other cases.***

For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then
choosing ONLY (a), (b) and (d) will get +4 marks;
choosing ONLY (a) and (b) will get +2 marks;
choosing ONLY (a) and (d) will get +2 marks;
choosing ONLY (b) and (d) will get +2 marks;
choosing ONLY (a) will get +1 mark;
choosing ONLY (b) will get +1 mark;
choosing ONLY (d) will get +1 mark;
choosing no option(s) (i.e., the question is unanswered) will get 0 marks and choosing any other option(s) will get −2 marks.

11. Select the correct statement(s).
(a) The non-stoichiometric form of NaCl is yellow and that of KCl is blue-lilac.
(b) Solids containing F-centre (Farbe) are paramagnetic.
(c) Non-stoichiometric compounds are called Berthollide compounds.
(d) Conduction by electrons is called *n*-type semi conductors.

12. Consider the cell:
$Pt|H_2(p_1\ atm)|H^+(x_1\ M)\ ||\ H^+(x_2\ M)|H_2(p_2\ atm)|Pt.$
The cell reaction be spontaneous if
(a) $p_1 = p_2$ and $x_1 > x_2$ (b) $p_1 = p_2$ and $x_1 < x_2$
(c) $x_1 = x_2$ and $p_1 > p_2$ (d) $x_1 = x_2$ and $p_1 < p_2$

13. Tyndall effect is applicable when
(a) the diameter of the dispersed particle is not much smaller than the wavelength of the light used
(b) the diameter of the dispersed particles is much smaller than the wavelength of the light used
(c) the refractive indices of the dispersed phase and the dispersion medium must be same
(d) the refractive indices of the dispersed phase and the dispersion medium must differ greatly in magnitude.

14. A gas can be liquefied
(a) above critical temperature
(b) under adiabatic expansion
(c) under pressure when it is cooled to below critical temperature
(d) at pressure higher than the critical pressure and the temperature lower than critical temperature.

15. Which of the following salts when dissolved in water undergo hydrolysis ?
(a) NaCl (b) NH_4Cl
(c) KCl (d) Na_3PO_4.

16. The basic theory behind Arrhenius' equation is that
(a) the number of effective collisions is proportional to the number of molecules above a certain threshold energy
(b) as the temperature increases, so does the number of molecules with energies exceeding the threshold energy.
(c) the rate constant is a function of temperature
(d) the activation energy and pre-exponential factor are always temperature independent.

SECTION 4

This section contains THREE (03) questions.
The answer to each question is a NON-NEGATIVE INTEGER.
For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+4***	***If ONLY the correct integer is entered;***
Zero Marks :	***0***	***In all other cases.***

17. The ratio between the root mean square velocity of H_2 at 50 K and that of O_2 at 800 K is _____.

18. Volume of oxygen gas (O_2) measured at 0°C and 1 atm pressure needed to burn completely 1 L of ethanol measured under the same conditions is _____.

19. Among the following, the number of elements showing only one non-zero oxidation state is _____.
O, Cl, F, N, P, Sn, Tl, Na, Ti

PAPER - II

SECTION 1

This section contains SIX (06) questions.
Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is (are) correct answer(s).
For each question, choose the option(s) corresponding to (all) the correct answer(s).
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+4***	***If only (all) the correct option(s) is(are) chosen;***
Partial Marks :	***+3***	***If all the four options are correct but ONLY three options are chosen;***
Partial Marks :	***+2***	***If three or more options are correct but ONLY two options are chosen, both of which are correct;***
Partial Marks :	***+1***	***If two or more options are correct but ONLY one option is chosen and it is a correct option;***
Zero Marks :	***0***	***If unanswered;***
Negative Marks :	***–2***	***In all other cases.***

For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then
choosing ONLY (a), (b) and (d) will get +4 marks;
choosing ONLY (a) and (b) will get +2 marks;
choosing ONLY (a) and (d) will get +2 marks;
choosing ONLY (b) and (d) will get +2 marks;
choosing ONLY (a) will get +1 mark;
choosing ONLY (b) will get +1 mark;
choosing ONLY (d) will get +1 mark;
choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
choosing any other option(s) will get –2 marks.

1. In the reaction at constant volume,

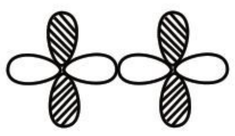
$$C_{(s)} + CO_{2(g)} \rightleftharpoons 2CO_{(g)}$$

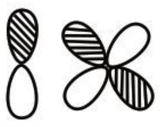
argon gas is added which does not take part in the reaction; choose the correct statement/s.
(a) The equilibrium constant is unchanged.
(b) The equilibrium shifts in the forward direction.
(c) The equilibrium shifts in the backward direction.
(d) The direction of equilibrium depends on the amount of argon added.

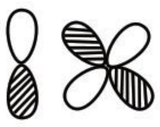
2. The correct statement(s) is/are
   (a) $BeCl_2$ is a covalent compound
   (b) $BeCl_2$ can form dimer
   (c) $BeCl_2$ is an electron-deficient molecule
   (d) the hybrid state of Be in $BeCl_2$ is sp^2.

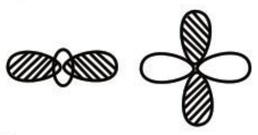
3. Match the orbital overlap figures shown in List-I with the description given in List-II and select the correct answer using the code given below the lists.

List-I

(P) 

(Q) 

(R) 

(S) 

List-II

1. p - d π antibonding
2. d - d σ bonding
3. p - d π bonding
4. d - d σ antibonding

Code :

	P	Q	R	S
(a)	2	1	3	4
(b)	4	3	1	2
(c)	2	3	1	4
(d)	4	1	3	2

4. Which is/are likely to show inert pair effect?
   (a) K (b) Mg (c) Ga (d) Pb

5. The hardness of water due to HCO_3^- is 122 ppm. Select the correct statement(s).
   (a) The hardness of water in terms of $CaCO_3$ is 200 ppm.
   (b) The hardness of water in terms of $CaCO_3$ is 100 ppm.
   (c) The hardness of water in terms of $CaCl_2$ is 222 ppm.
   (d) The hardness of water in terms of $Mgcl_2$ is 95 ppm.

6. Select the correct statements:
   (a) The heat of hydration of the di positive earth metal ions increases with an increase in their ionic size.
   (b) Hydration of alkali metal ions is less than that of group 2.
   (c) Alkaline earth metal ions, because of their much larger charge-to-size ratio exert a much stronger electrostatic attraction on the oxygen of water molecule surrounding them.
   (d) Melting point of sodium halides is as follows: NaF > NaCl > NaBr > NaI.

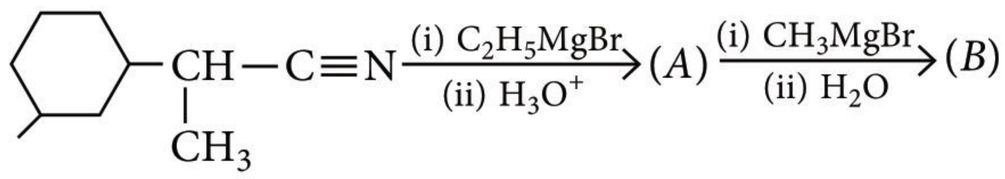
SECTION 2

This section contains THREE (03) question stems. There are TWO (02) questions corresponding to each question stem.
The answer to each question is a NUMERICAL VALUE.
For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+2***	***If ONLY the correct numerical value is entered at the designated place;***
Zero Marks :	***0***	***In all other cases.***

Question Stem for Question Nos. 7 and 8

Question Stem



7. The number of chiral centre in (*B*) is _____.
8. The mass percentage of carbon in [*A*] is _____.

Question Stem for Question Nos. 9 and 10

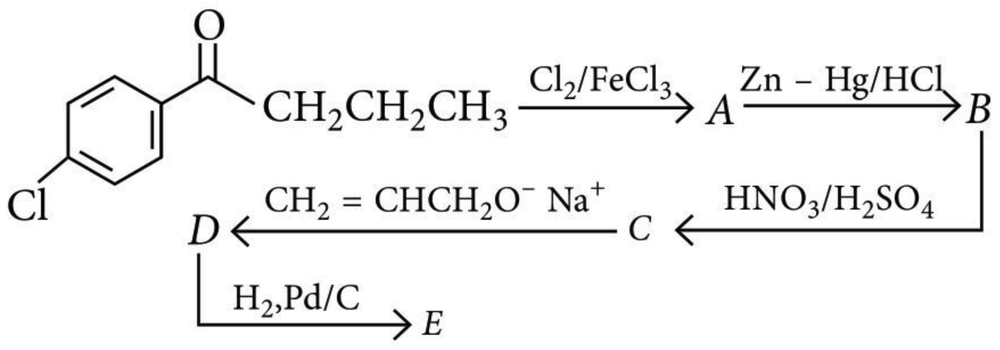
Question Stem

Bleaching powder is a solid combination of chlorine and slaked lime. Its IUPAC name is calcium hypochloride it is commonly used to sanitise public swimming pools and disinfect drinking water. In organic chemistry it is used as an oxidizing agent.

9. Bleaching powder contains a salt of an oxoacid as one of its component. The anhydride of that oxoacid is Cl_2O_x, then the value of 'x' is_____.
10. 25 mL of household bleach solution was mixed with 30 mL of 0.50 M KI and 10 mL of 4 N acetic acid. In the titration of the liberated iodine, 48 mL of 0.25 N $Na_2S_2O_3$ was used to reach the end point. The molarity of the household bleach solution is _____.

Question Stem for Question Nos. 11 and 12

Question Stem



11. The number of π-bond in '*D*' is _____.

12. The number of carbon in '*E*' is _____.

SECTION 3

This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions. Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is the correct answer. For each question, choose the option corresponding to the correct answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+3***	***If ONLY the correct option is chosen;***
Zero Marks :	***0***	***If none of the options is chosen (i.e., the question is unanswered);***
Negative Marks :	***–1***	***In all other cases.***

Paragraph-1

All carbohydrates contain one or more asymmetric carbon atom and exhibit optical activity. All carbohydrates respond to Molisch's test. Glucose, $C_6H_{12}O_6$, also called dextrose and grape sugar occurs in grapes, honey and many other fruits. Glucose undergoes the general reactions of aldehydes i.e. reduces Tollens, Fehling, Benedict's solution.

13. The correct statement regarding glucose is
(a) it is dextrorotatory
(b) it is optically active
(c) it can reduce Tollens reagent
(d) all of these.

14. The pyranose structure of glucose contains
(a) six membered ring
(b) epoxy linkage
(c) hydroxy groups
(d) all of these.

Paragraph-2

The polymer which can conduct electricity is called conducting polymer. The conducting polymers may be conductive element filled polymers or conjugated π-electrons conducting polymer or it can also be doped conducting polymer or blended conducting polymers. Conducting polymers find great importance in electronics, micro electronics and biomedical fields.

15. The conductivity of the polymers depend upon
(i) Length of conjugation in a given polymer.
(ii) Suitable dopant material.
(a) (i) is true and (ii) is false
(b) (i) is false and (ii) is true
(c) both (i) and (ii) are false
(d) both (i) and (ii) are true.

16. Presence of conjugated π-electrons in a polymer
(a) increase its conductivity
(b) decrease its conductivity
(c) may increase or decrease its conductivity
(d) none of these.

SECTION 4

This section contains THREE (03) questions. The answer to each question is a NON-NEGATIVE INTEGER.

For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	***+4***	***If ONLY the correct integer is entered;***
Zero Marks :	***0***	***In all other cases.***

17. The number of ionic carbides among CaC_2, Al_4C_3, SiC and Be_2C is _____.

18. The total number of alkenes (consider isomer also) possible by dehydrobromination of 3-bromo-3-cyclopentylhexane using alcoholic KOH is _____.

19. The oxidation number of phosphorus in $Ba(H_2PO_2)_2$ is _____.

SOLUTIONS

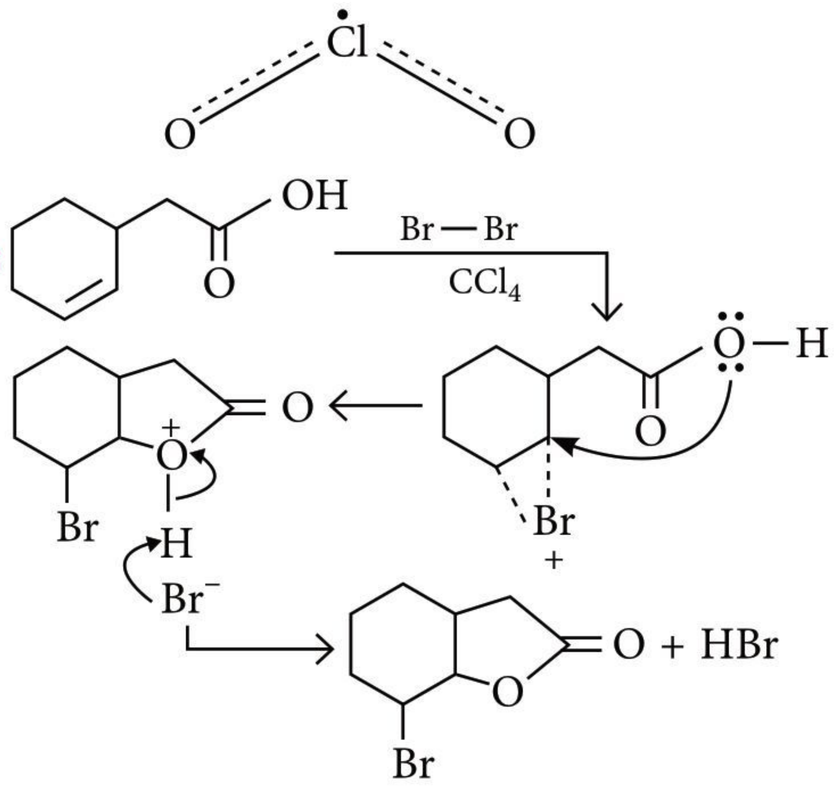
PAPER - I

1. (c) : (c) forms a stable carbocation, due to flexible structure so will give fastest rate.

2. (a) : Matte contains Cu_2S, FeS and silica.

3. (a) : The odd electron on Cl in ClO_2 is delocalised due to involvement of $p\pi$-$d\pi$ bonding that's why ClO_2 does not dimerise.

4. (d) :



5. (46) : Taking into consideration the above facts following conclusions can be drawn:

(i) Since *A* reacts with CH_3COOH in presence of H_2SO_4 to yield *B* which is an ester so we can conclude that *A* is an alcohol.

(ii) A primary alcohol on mild oxidation yields an aldehyde *C* on reaction with 50% KOH followed by acidification gives alcohol *A* and another compound *D*. It appears to be Cannizzaro's reaction, hence *C* must be an aldehyde and *D* must be an acid.

(iii) Formation of HCN by dehydration of *E* establishes that *E* is $HCONH_2$ and hence *D* is HCOOH.

(iv) Therefore the alcohol *A* produced along with *D* (*i.e.* HCOOH) during Cannizzaro's reaction of *C* must be CH_3OH and so *C* must be HCHO (an aldehyde).

Thus the various compounds are:

A - CH_3OH (Alcohol, Methanol)

B - CH_3COOCH_3 (Ester, Methyl acetate)

C - HCHO (Aldehyde, Formaldehyde)

D - HCOOH (Acid, Formic acid)

E - $HCONH_2$ (Amide, Formamide).

Molecular mass of '*D*' = 46 g/mol

6. (4) : The number of hydrogen atom in '*A*' is '4'.

7. (1) : In *B*, there is one ketonic and one aldehydic group.

8. (6) : The number of carbon present in compound '*B*' is '6'.

9. (6.24) : $\Delta G^\circ = (-5.40) + (-0.84) = -6.24$ kJ

10. (0.84) : $\Delta G^\circ = -0.84$ kJ

11. (a, b, c, d) **12. (a, d)**

13. (a, d)

14. (b, c, d) : Above critical temperature, a gas cannot be liquefied.

15. (b, d) : Salts of strong acids and strong bases do not undergo hydrolysis.

16. (a, b, c, d)

17. (1) : $$\frac{C_{rms H_2}}{C_{rms O_2}} = \sqrt{\frac{3\times R\times 50}{2}} \times \sqrt{\frac{32}{3\times R\times 800}} = 1$$

18. (3.5) : $$\underset{1\text{ vol.}}{C_2H_5OH} + \frac{7}{2}\underset{3.5\text{ vol.}}{O_2} \rightarrow \underset{2\text{ vol.}}{2CO_2} + \underset{3\text{ vol.}}{3H_2O}$$

According to the above equation,
1 vol. or 1 litre of ethanol requires 3.5 vol. or 3.5 litres of O_2 to burn completely.

19. (2) : There are only two elements which show only one non-zero oxidation state :
Na exhibits only +1 and F exhibits only –1 oxidation state. Rest of the elements show more than one non-zero oxidation states.

PAPER - II

1. (a) : If the reaction takes place at constant volume, addition of an inert gas like argon will not change the molar concentrations of the reactants and products. Hence, the state of equilibrium will remain unaffected.

2. (a, b, c) : $BeCl_2$ is *sp*-hybridised.

3. (c)

4. (c, d) : As we go down the group, inert pair effect increases.

Quotable Quote

"Don't read success stories, you will only get a message. Read failure stories, you will get some ideas to get success."

A.P.J. Abdul Kalam

5. (b, d) : Since 2 mol of HCO_3^- is present, there should be one mole each of $CaCO_3$, $CaCl_2$ and $MgCl_2$ to have equal hardness.

Molecular mass of HCO_3^- = 61 g/mol

ppm of HCO_3^- = 61 × 2 = 122 g in 10^6 mL H_2O

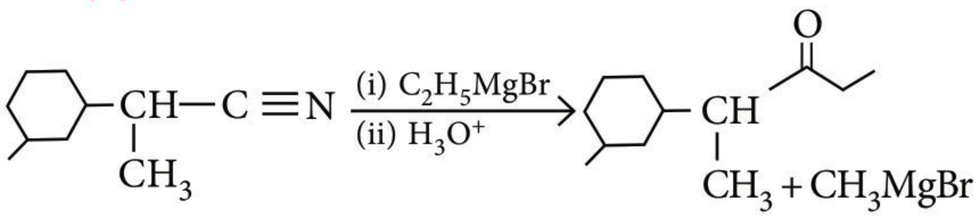
1 mole of $CaCO_3$ = 100 ppm (M. Wt. of $CaCO_3$ = 100 g/mol)

1 mol of $CaCl_2$ = 111 ppm (M. Wt. of $CaCl_2$ = 111 g/mol

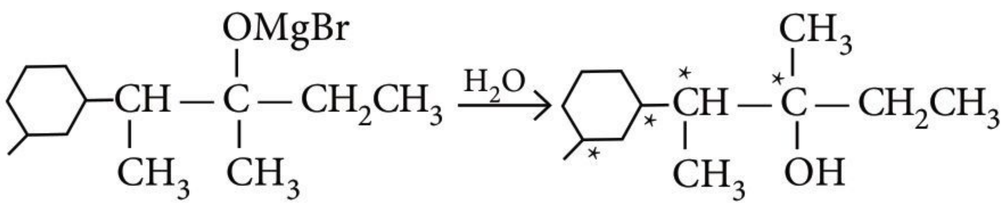
1 mol of $MgCl_2$ = 95 ppm (M.Wt. of $MgCl_2$ = 95 g/mol)

6. (b, c, d)

7. (4) :



(*A*)



(*B*)

8. (79.12) : Molecular mass of A

= 12 × 12 + 22 × 1 + 16 × 1

= 144 + 22 + 16 = 182

$$\%\ of\ C = \frac{\text{Mass of carbon}}{\text{Total mass of compound}} \times 100 = \frac{144}{182} \times 100$$

= 79.12

9. (1) : $CaOCl_2$ is bleaching powder.

It is Ca(OCl)(Cl), that means it contains HOCl as oxyacid. Its anhydride is Cl_2O.

$$2HOCl \xrightarrow{-H_2O} Cl_2O$$

The value of *x* is 1.

10. (0.24) : Household bleach + KI → I_2 + Products

$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$

Amount of $Na_2S_2O_3$ used = V × H

= $48 \times 10^{-3} \times 0.25 = 12 \times 10^{-3}$ mol

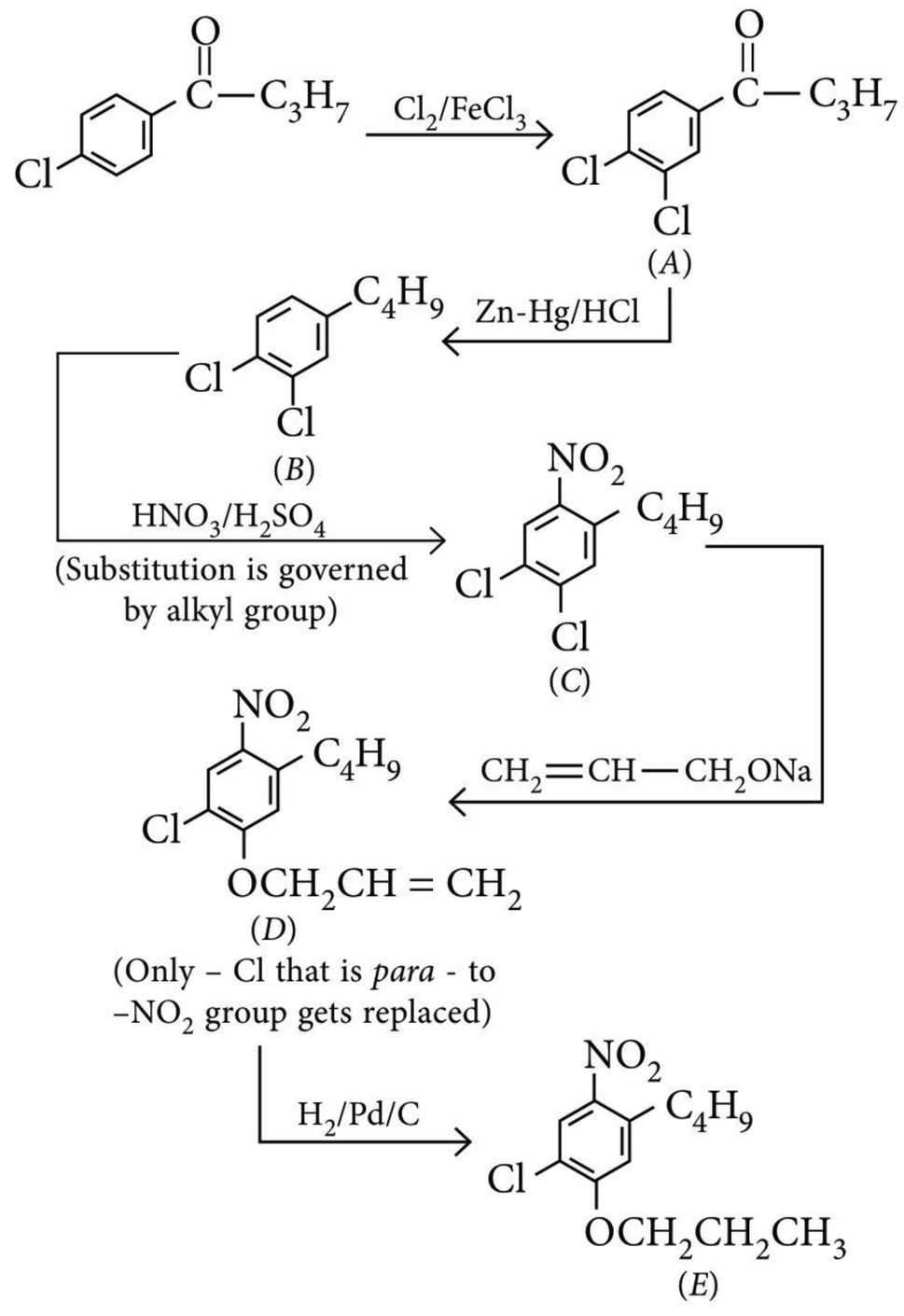
Amount of I_2 generated = $\frac{1}{2}(12 \times 10^{-3}) = 6 \times 10^{-3}$ mol

Assuming 1 mol of household bleach produces 1 mol of I_2.

The amount of household bleach in 25 mL Solution = 6×10^{-3} mol

$$\text{Molarity} = \frac{n}{V} = \frac{6 \times 10^{-3}\ \text{mol}}{25 \times 10^{-3}\ \text{L}} = 0.24\ \text{M}$$

11. (5) :



12. (13)

13. (d)

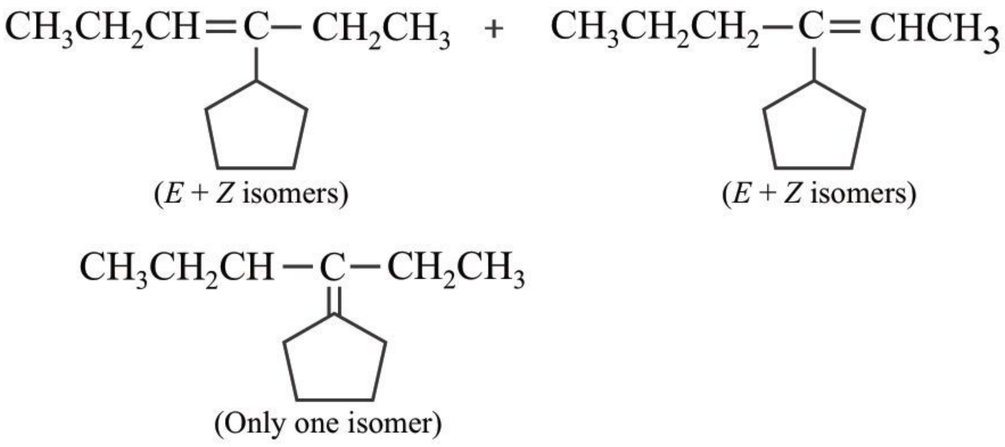
14. (d)

15. (d)

16. (a)

17. (3) : Carbides of metal (Ca, Al and Be) are ionic while SiC covalent.

18. (5) : Total no. of alkenes will be 5



19. (1) : In $Ba(H_2PO_2)_2$, we have 2 + 2 (2 + *x* – 4) = 0

or 2 + 4 + 2*x* – 8 = 0

or 2*x* = 8 – 4 – 2 or *x* = 2/2 = +1

CUET (UG)

PRACTICE PAPER 2022

Section II of CUET (UG) is Domain specific. In this section of Chemistry 40 questions to be attempted out of 50.

Max. Marks : 200 Marks | Time : 45 minutes

Multiple Choice Questions (MCQs)

1. In the process of extraction of gold,

$$\text{Roasted gold ore} + CN^- + H_2O \xrightarrow{O_2} [X] + OH^-$$

$$[X] + Zn \rightarrow [Y] + Au.$$

Identify the complexes $[X]$ and $[Y]$.

(a) $X = [Au(CN)_2]^-$, $Y = [Zn(CN)_4]^{2-}$

(b) $X = [Au(CN)_4]^{3-}$, $Y = [Zn(CN)_4]^{2-}$

(c) $X = [Au(CN)_2]^-$, $Y = [Zn(CN)_6]^{4-}$

(d) $X = [Au(CN)_4]^-$, $Y = [Zn(CN)_4]^{2-}$.

2. S_N1 reactivity of the following halides will be in the order

(i) $(CH_3)_3CBr$ (ii) $(C_6H_5)_2CHBr$

(iii) $(C_6H_5)_2C(CH_3)Br$ (iv) $(CH_3)_2CHBr$

(v) C_2H_5Br

(a) (v) > (iv) > (i) > (ii) > (iii)

(b) (ii) > (i) > (iii) > (v) > (iv)

(c) (i) > (iii) > (v) > (ii) > (iv)

(d) (iii) > (ii) > (i) > (iv) > (v)

3. The cell, $Zn_{(s)} \mid Zn^{2+}(1\ M) \parallel Cu^{2+}(1\ M) \mid Cu_{(s)}$; ($E^\circ_{cell} = +1.10$ V) was allowed to be completely discharged at 298 K. The relative concentration of Zn^{2+} to Cu^{2+} *i.e.*, $\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$ is

(a) 9.65×10^4 (b) antilog (24.08)

(c) 37.3 (d) $10^{37.3}$

4. P_4(white) + P (an alkaline solution) $\longrightarrow$ Q (reducing gas) + R

R + dil. $H_2SO_4 \longrightarrow T$(ppt.) + S (oxy-acid of P)

T gives apple green colour in the flame.

Thus, P, Q, R, S and T respectively are

(a) $Ba(OH)_2$; PH_3 ; $Ba(H_2PO_2)_2$; H_3PO_2 ; $BaSO_4$

(b) $Ca(OH)_2$; P_2H_4 ; $Ca(H_2PO_2)_2$; H_3PO_2 ; $CaSO_4$

(c) $Ba(OH)_2$; PH_3 ; $Ba(H_2PO_2)_3$; H_3PO_3 ; $BaSO_4$

(d) $Ba(OH)_2$; P_2H_4 ; $Ba(H_2PO_2)_2$; H_3PO_3 ; $BaSO_4$

5. Rate of physisorption increases with

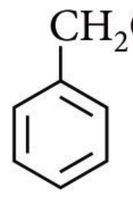
(a) decrease in temperature

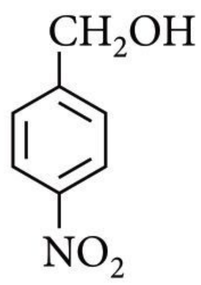
(b) increase in temperature

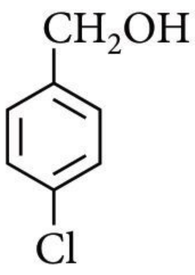
(c) decrease in pressure

(d) decrease in surface area.

6. Mark the correct increasing order of reactivity of the following compounds with HBr/HCl.

(i) 

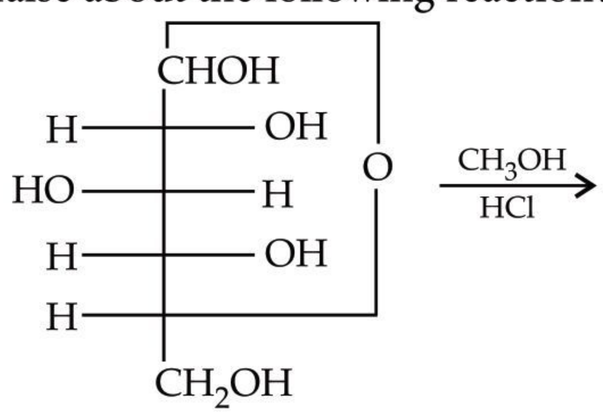
(ii) 

(iii) 

(a) (i) < (ii) < (iii) (b) (ii) < (i) < (iii)

(c) (ii) < (iii) < (i) (d) (iii) < (ii) < (i)

7. What is false about the following reaction?



(a) A carbocation participates.

(b) Only one —OH group becomes $-OCH_3$.

(c) The product is an acetal.

(d) The third —OH group from anomeric carbon becomes $-OCH_3$ group.

8. Which of the following statements is true for ionic solids?

(a) Ionic solids are soluble in CCl_4, C_6H_6, etc.

(b) Under the electric field cations and anions acquire translatory motion in opposite directions.

(c) Structural units have strong electrostatic forces of attraction.

(d) Structural units have dipole-dipole interactions.

9. An aqueous solution of a substance gives a white precipitate on treatment with dilute hydrochloric acid, which dissolves on heating. When hydrogen sulphide is passed through the hot acidic solution, a black precipitate is obtained. The substance is a

(a) Hg_2^{2+} salt (b) Cu^{2+} salt

(c) Ag^{+} salt (d) Pb^{2+} salt.

10. Which of the following is Hoffmann mustard oil reaction?

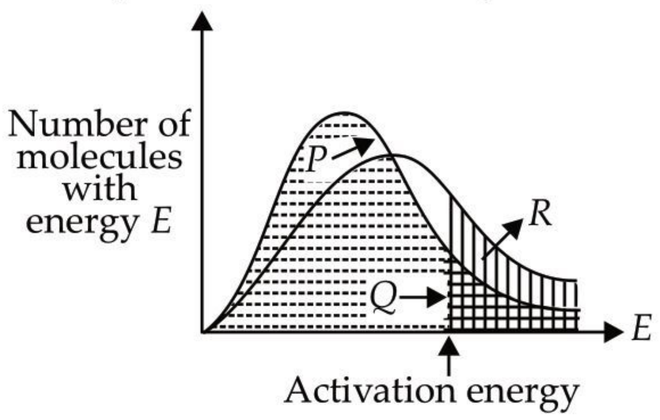
(a) Reaction of aromatic amine with iodoform

(b) Reaction of primary amine with $CHCl_3$

(c) Reaction of primary amine with CS_2 and $HgCl_2$

(d) Reaction of secondary amine with nitrous acid

11. The distribution of the number of molecules with energy E is given in the figure for two temperatures, T_1 and a higher temperature T_2. The letters P, Q, R refer to the separate and differently shaded areas.



Which expression gives the fraction of the molecules present which have at least the activation energy at the higher temperature T_2?

(a) $\frac{Q}{P}$ (b) $\frac{Q+R}{P+Q}$

(c) $\frac{Q+R}{P}$ (d) $\frac{Q+R}{P+Q-R}$

12. Which of the following transition elements shows the highest oxidation state?

(a) Mn (b) Fe (c) V (d) Cr

13. In the reaction ;

$$CH_3\underset{\underset{I}{|}}{CH}CH_3 \xrightarrow{\text{alc. KOH}} X \xrightarrow[\text{Peroxide}]{\text{HBr}} Y \xrightarrow[\text{Acetone}]{\text{NaI}} Z$$

Here, Z is

(a) $CH_3CH_2CH_2I$ (b) $CH_3\underset{\underset{I}{|}}{CH}-CH_3$

(c) $CH_3\underset{\underset{I}{|}}{C}=CHI$ (d) $CH_3\underset{\underset{I}{|}}{CH}CH_2I$

14. The conductivity of 0.001028 mol L^{-1} acetic acid is 4.95×10^{-5} S cm^{-1}. Calculate its dissociation constant if Λ°_m for acetic acid is 390.5 S cm^2 mol^{-1}.

(a) 1.78×10^{-5} mol L^{-1} (b) 1.87×10^{-5} mol L^{-1}

(c) 0.178×10^{-5} mol L^{-1} (d) 0.0178×10^{-5} mol L^{-1}

15. Among Al_2O_3, SiO_2, P_2O_5 and SO_3, the correct order of acid strength is

(a) $P_2O_5 < Al_2O_3 < SiO_2 < SO_3$

(b) $SiO_2 < SO_3 < Al_2O_3 < P_2O_5$

(c) $Al_2O_3 < SiO_2 < P_2O_5 < SO_3$

(d) $SO_3 < P_2O_5 < SiO_2 < Al_2O_3$

16. Adsorption of gases on solid surface is generally exothermic because

(a) enthalpy is positive (b) entropy decreases

(c) entropy increases (d) free energy increases.

17. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at

(a) C_5' and C_2' respectively of the sugar molecule

(b) C_2' and C_5' respectively of the sugar molecule

(c) C_1' and C_5' respectively of the sugar molecule

(d) C_5' and C_1' respectively of the sugar molecule.

18. In a reaction between A and B, the initial rate of reaction r_0 was measured for different initial concentrations of A and B as given below

A/mol L^{-1}	0.20	0.20	0.40
B/mol L^{-1}	0.30	0.10	0.05
r_0/mol $L^{-1}s^{-1}$	5.07×10^{-5}	5.07×10^{-5}	1.43×10^{-4}

The order of the reaction with respect to A is

(a) 1.5 (b) 0.5 (c) 1 (d) 2

19. For H_3PO_3 and H_3PO_4, the correct choice is

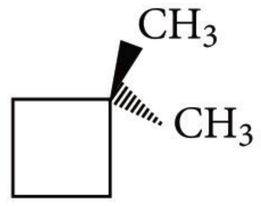
(a) H_3PO_3 is dibasic and reducing

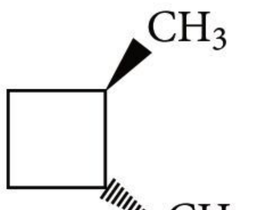
(b) H_3PO_3 is dibasic and non-reducing

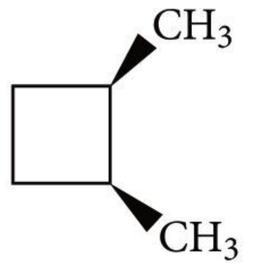
(c) H_3PO_4 is tribasic and reducing

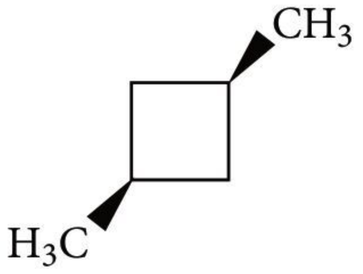
(d) H_3PO_3 is tribasic and non-reducing.

20. Which of the following is a chiral molecule?

(a) 

(b) 

(c) 

(d) 

21. Mutation in DNA occurs due to changes in the sequence of

(a) nitrogeneous bases (b) ribose units

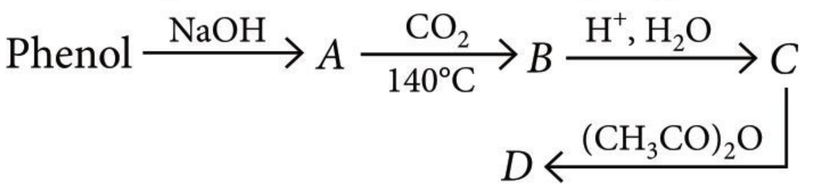
(c) phosphate units (d) hydrogen bonds.

22. Benzene diazonium chloride on reaction with phenol in weakly basic medium gives
(a) diphenyl ether (b) *p*-hydroxyazobenzene
(c) chlorobenzene (d) benzene.

23. The radii of Na^+ and Cl^- ions are 95 pm and 181 pm respectively. The edge length of NaCl unit cell is
(a) 276 pm (b) 138 pm
(c) 552 pm (d) 415 pm

24. The ore which contains copper and iron both is
(a) cuprite (b) chalcocite
(c) chalcopyrite (d) malachite.

25. The end product in the following sequence is



(a) salicylic acid (b) salicylaldehyde
(c) phenyl acetate (d) aspirin.

26. Which of these is a hypnotic?
(a) Metaldehyde (b) Acetaldehyde
(c) Paraldehyde (d) None of these

27. Which of the following reactions is possible at anode?
(a) $2Cr^{3+} + 7H_2O \rightarrow Cr_2O_7^{2-} + 14^+$
(b) $F_2 \rightarrow 2F^-$
(c) $(1/2)O_2 + 2H^+ \rightarrow H_2O$
(d) None of these

28. Which of the following is not the characteristic of zinc?
(a) It is a volatile metal.
(b) It dissolves in alkali forming sodium zincate.
(c) It is brittle at very high temperature.
(d) Zinc dust is used as a reducing agent.

29. Select the incorrect statement.
(a) Iodine number is a measure of unsaturation in an oil or fat.
(b) Insulin hormone is secreted from pancreas.
(c) Thyroxine hormone is secreted from thyroid gland.
(d) Iodine number is measured as number of grams of iodine that combine with 10 g of oil or fat.

30. Dopping of AgCl crystals with $CdCl_2$ results in
(a) Schottky defect (b) Frenkel defect
(c) Substitutional cation vacancy
(d) Formation of F-centres.

31. $CH_3NH_2 + CHCl_3 + KOH \rightarrow$ nitrogen containing compound + KCl + H_2O.
Nitrogen containing compound is
(a) $CH_3-C\equiv N$ (b) $CH_3-NH-CH_3$
(c) $CH_3-\bar{N}\equiv\overset{+}{C}$ (d) $CH_3\overset{+}{N}\equiv\bar{C}$

32. The pair of compounds in which both the compounds give positive test with Tollen's reagent is
(a) glucose and sucrose
(b) fructose and sucrose
(c) acetophenone and hexanal
(d) glucose and fructose.

33. The reason for the stability of Gd^{3+} ion is
(a) half-filled 4*f*-subshell
(b) completely filled 4*f*-subshell
(c) possesses the general electronic configuration of noble gases
(d) empty 4*f*-subshell.

34. Benadryl is used as
(a) antiseptic (b) disinfectant
(c) analgesic (d) antihistamine.

Assertion & Reason Based MCQs

For question numbers 35-38, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) If both assertion and reason are correct and reason is the correct explanation of assertion.
(b) If both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) If assertion is correct but reason is wrong.
(d) If assertion is wrong but reason is correct.

35. **Assertion :** $[Fe(H_2O)_5NO]SO_4$ is paramagnetic.
Reason : The Fe in $[Fe(H_2O)_5NO]SO_4$ has three unpaired electrons.

36. **Assertion :** Assuming the elementary reaction to occur through molecular collisions, molecularity of a reaction is defined as the number of atoms or molecules which collide together for reaction to occur.
Reason : The sum of powers of the concentration of the reactants in the rate law expression is called the order of the chemical reaction.

37. **Assertion :** Alcohols have higher boiling points than ethers of comparable molecular masses.
Reason : Alcohols and ethers are isomeric compounds.

38. **Assertion :** Certain narcotics are used as analgesics.
Reason : Narcotics lower the body temperature in high fever.

Match the Column

39. Match the complexes in Column I with their properties listed in Column II.

	Column I		Column II
(A)	$[Co(NH_3)_4(H_2O)_2]Cl_2$	(p)	geometrical isomers
(B)	$[Pt(NH_3)_2Cl_2]$	(q)	paramagnetic
(C)	$[Co(H_2O)_5Cl]Cl$	(r)	diamagnetic
(D)	$[Ni(H_2O)_6]Cl_2$	(s)	metal ion with +2 oxidation state

	A	B	C	D
(a)	p, q, s	p, r, s	q, s	q, s
(b)	p, r, s	p, q, r	q, r	p, s
(c)	p, q	p, s, r	p, q	q, r
(d)	p, q, r	p, q, s	q, s	p, r

40. Match the column I with its characteristic given in column II

	Column I		Column II
(A)	Kertain	(p)	protein
(B)	Haemoglobin	(q)	β-pleated protein
(C)	Riboflavin	(r)	α-amino acid
(D)	Glycine	(s)	Water soluble vitamin

	A	B	C	D
(a)	p	r	q	s
(b)	p, q	p	s	r
(c)	p, q	r	p	s
(d)	p	r	s	q

Case Based MCQs

Case I : Read the passage given below and answer the following questions from 41 to 45.

van't Hoff, in order to account for extent of association or dissociation of solute in solution introduced a factor '*i*' known as the van't Hoff factor.

$$i = \frac{\text{Observed colligative property (actual)}}{\text{Theoretical colligative property (expected)}}$$

$$i = \frac{\text{Normal (calculated) molecular mass}}{\text{Observed (experimental) molecular mass}} = \frac{M_c}{M_o}$$

$$i = \frac{\text{Number of molecules actually present}}{\text{Number of molecules expected to be present}}$$

41. Which of the following colligative property can provide molar mass of proteins (or polymers or colloids) with greatest precision?
(a) Osmotic pressure
(b) Elevation of boiling point
(c) Depression in freezing point
(d) Relative lowering of vapour pressure

42. A 0.001 molal solution of $[Pt(NH_3)_4Cl_4]$ in water had a freezing point depression of 0.0054 °C. If K_f for water is 1.80 °C m^{-1}, the correct formulation for the above molecule is
(a) $[Pt(NH_3)_4Cl_3]Cl$ (b) $[Pt(NH_3)_4Cl_2]Cl_2$
(c) $[Pt(NH_3)_4Cl]Cl_3$ (d) $[Pt(NH_3)_4Cl_4]$

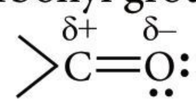
43. We have three aqueous solution of NaCl labelled as '*A*', '*B*' and '*C*' with concentrations 0.1 M, 0.01 M and 0.001M, respectively. The value of van't Hoff factor for complete dissociation of the solute will be in the order
(a) $i_A < i_B < i_C$ (b) $i_A > i_B > i_C$
(c) $i_A = i_B = i_C$ (d) $i_A < i_B > i_C$

44. The van't Hoff factor for 0.1 M $Ba(NO_3)_2$ solution is 2.74. The degree of dissociation is
(a) 91.3 % (b) 74 % (c) 87 % (d) 100 %

45. If α is the degree of dissociation of Na_2SO_4, the van't Hoff's factor (*i*) used for calculating the molecular mass is
(a) 1 + α (b) 1 – α (c) 1 + 2α (d) 1 – 2α

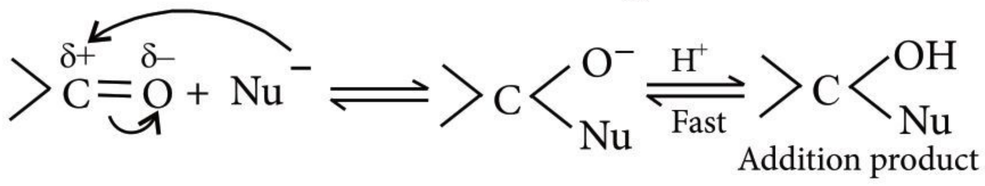
Case II : Read the passage given below and answer the following questions from 46 to 50.

Carbonyl compounds are highly reactive due to the presence of polar carbonyl group.



Polar nature of carbonyl group

Thus carbonyl compounds are readily attacked by nucleophilic reagent (Nu^-) to form new carbon-nucleophile (C—Nu) bond and ultimately results in the formation of an anion intermediate. Negative charge of oxygen atom is satisfied by a positively charged ion either from solvent or from the reagent.



Addition product

– In this reaction carbon atom of carbonyl group changes from sp^2 to sp^3 hybridized.
– Above reaction is catalyzed by acids, since protonation of oxygen atom increases the positive charge on carbon atom.

46. Aldehydes and ketones do not give addition reaction with

(a) HCN (b) $NaHSO_3$

(c) Both HCN and $NaHSO_3$

(d) $HCl_{(aq)}$

47. $C_6H_5CHO + HCN \rightarrow C_6H_5CH(CN)OH$

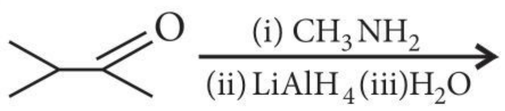
The product would be

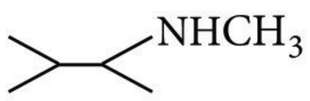
(a) racemate (b) optically active

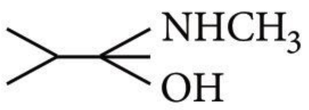
(c) a meso compound

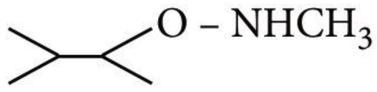
(d) mixture of diastereomers.

48. The major organic product formed from the following reaction :



(a) 

(b) 

(c) 

(d) 

49. Which of the following reagents reacts differently with HCHO, CH_3CHO and CH_3COCH_3?

(a) HCN (b) NH_2NH_2

(c) NH_2OH (d) NH_3

50. The addition of HCN to carbonyl compounds is an example of

(a) nucleophilic substitution

(b) electrophilic addition

(c) nucleophilic addition

(d) electrophilic substitution.

SOLUTIONS

1. (a) : $2Au + 4CN^- + H_2O + \frac{1}{2}O_2 \longrightarrow 2[Au(CN)_2]^- + 2OH^-$

$2[Au(CN)_2]^- + Zn \rightarrow [Zn(CN)_4]^{2-} + 2Au$

2. (d) : In S_N1 reaction, the rate determining step is the formation of carbocation which in turn depends upon the stability of carbocation. The stability of carbocations is

$(C_6H_5)_2\overset{+}{C}(CH_3) > (C_6H_5)_2\overset{+}{C}H > (CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3\overset{+}{C}H_2$

Hence, the order of reactivity is

$(C_6H_5)_2C(CH_3)Br > (C_6H_5)_2CHBr > (CH_3)_3CBr > (CH_3)_2CHBr > CH_3CH_2Br$

3. (d) : $E = E^\circ - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

$0 = 1.10 - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

$\log\frac{[Zn^{2+}]}{[Cu^{2+}]} = 37.3 \quad \therefore \quad \frac{[Zn^{2+}]}{[Cu^{2+}]} = 10^{37.3}$

4. (a) : $\underset{(P)}{3Ba(OH)_2} + 2P_4 + 6H_2O \longrightarrow \underset{(R)}{3Ba(H_2PO_2)_2} + \underset{(Q)}{2PH_3}$

$\underset{(R)}{Ba(H_2PO_2)_2} + H_2SO_4 \longrightarrow \underset{(T)}{BaSO_4} + \underset{(S)}{2H_3PO_2}$

gives apple green colour in the flame

5. (a) : Since the adsorption process is exothermic, the physical adsorption occurs readily at low temperature and increases with decreasing temperature (Le-Chatelier's principle).

6. (c) **7. (b)** **8. (c)**

9. (a) : $Hg_2^{2+} + HCl_{(dil)} \rightarrow \underset{\text{(white)}}{Hg_2Cl_2}\downarrow$

$Hg_2Cl_2 \xrightarrow{\Delta} HgCl_2 + Hg$

$Hg_2^{+2} + H_2S \rightarrow \underset{\text{Black}}{HgS}\downarrow + Hg + 2H^+$

10. (c) : $RNH_2 + S{=}C{=}S \longrightarrow RNH{-}\overset{\overset{S}{\|}}{C}{-}SH$

$R{-}N{=}C{=}S + HgS + 2HCl \xleftarrow[\text{Heat}]{HgCl_2}$ (Alkyl isothiocyanate)

This reaction is called Hoffmann mustard oil reaction.

11. (b) : The number of molecules with energy greater than the activation energy at T_2 is given by $Q + R$.

Total number of molecules is $P + Q$.

The required fraction is $\frac{Q+R}{P+Q}$.

12. (a) : $Mn(3d^5 4s^2)$ shows a maximum oxidation state of +7.

13. (a) : $CH_3{-}\underset{\underset{Br}{|}}{CH}{-}CH_3 \xrightarrow{\text{alc. KOH}} CH_3{-}CH{=}CH_2$

$CH_3{-}CH_2{-}CH_2Br \xleftarrow[\text{Peroxide}]{HBr}$

$\xrightarrow[\text{Acetone}]{NaI} CH_3CH_2CH_2I$

14. (a) : $\Lambda_m = \frac{\kappa}{c} = \frac{4.95\times10^{-5}\ S\ cm^{-1}}{0.001028\ mol\ L^{-1}} \times \frac{1000\ cm^3}{L}$

$= 48.15\ S\ cm^2\ mol^{-1}$

$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{48.15}{390.5} = 0.1233$

$\kappa = \frac{c\alpha^2}{(1-\alpha)} = \frac{0.001028\times(0.1233)^2}{1-0.1233} = 1.78\times10^{-5}\ mol\ L^{-1}$

15. (c) : With decrease in size from Al to S, the basic nature of oxide decreases and acidic nature increases.

$Al_2O_3 < SiO_2 < P_2O_5 < SO_3$

Al_2O_3 is amphoteric, SiO_2 is slightly acidic whereas P_2O_5 and SO_3 are the anhydrides of acids H_3PO_3 and H_2SO_3.

16. (b): When a gas is adsorbed on a solid surface, the movement of its molecules becomes restricted. This decreases the entropy of the system. For spontaneous process ΔG is always negative.

$\Delta H = \Delta G + T\Delta S$

Hence ΔH will also be negative which indicates that adsorption of gases on solid surface will be exothermic.

17. (c) **18. (a)** **19. (a)**

20. (b) **21. (a)** **22. (b)**

23. (c) : In a fcc lattice, the distance between the cation and anion is equal to the sum of their radii, which is equal to half of the edge length of unit cell,

$i.e.\ r^+ + r^- = \frac{a}{2}$ (where a = edge length)

$r^+ = 95$ pm, $r^- = 181$ pm

Edge length $= 2r^+ + 2r^- = (2 \times 95 + 2 \times 181)$ pm

$= (190 + 362)$pm $= 552$ pm

24. (c) : Cuprite : Cu_2O, Chalcocite : Cu_2S

Chalcopyrite : $CuFeS_2$, Malachite : $Cu(OH)_2 \cdot CuCO_3$

25. (d) **26. (c)**

27. (a) : $2Cr^{3+} + 7H_2O \rightarrow Cr_2O_7^{2-} + 14H^+$

O.S. of Cr changes fro +3 to +6 by loss of electrons.

At anode oxidation takes places.

28. (c) : Zinc is brittle at ordinary temperature but not at high temperature.

29. (d): Iodine number is defined as number of grams of iodine that combine with 100 g of oil or fat.

30. (c) : Two Ag^+ ions will be replaced by one Cd^{2+}, so there is one vacancy for each Cd^{2+} added.

31. (d): $CH_3NH_2 + CHCl_3 + 3KOH\ (alc.) \longrightarrow CH_3\overset{+}{N}\overset{-}{C} + 3KCl + 3H_2O$

This is known as carbylamine reaction.

32. (d): Aldehydes and α-hydroxyketones give positive Tollens' test. Both glucose containing – CHO group and fructose containing – $COCH_2OH$ group react with Tollen's reagent (ammoniacal silver nitrate solution) form a silver mirror or black precipitate.

33. (a) : $Gd(Z = 64) \rightarrow [Xe]\ 4f^7 5d^1 6s^2$

$\therefore\ Gd^{3+} \rightarrow [Xe]4f^7$

Gd^{3+} is highly stable due to stable half-filled configuration.

34. (d)

35. (a) : In compound $[Fe(H_2O)_5NO]SO_4$ oxidation state of Fe is

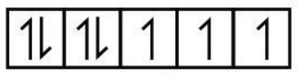
$x + 5 \times 0 + 1 = +2\ \ \therefore\ \ x = +1$

Here Fe has +1 oxidation states

$Fe^+ \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^1$

Due to strong field ligand one electron shifted from 4*s* to 3*d* thus showing d^7 configuration.

Fe^+



36. (b) **37. (b)** **38. (c)**

39. (a) **40. (b)** **41. (a)**

42. (b): $\Delta T_f = iK_f \cdot m \Rightarrow i = \frac{\Delta T_f}{K_f \cdot m}$

$$i = \frac{0.0054}{1.80 \times 0.001} = 3$$

It means 3 ions are produced on dissociation hence, formula must be $[Pt(NH_3)_4Cl_2]Cl_2$.

43 (c)

44 (c) : Degree of dissociation

$$(\alpha) = \frac{i-1}{n-1}$$

n is number of ions produced from one molecule

$$\alpha = \frac{2.74-1}{3-1} = \frac{1.74}{2} = 0.87$$

Degree of dissociation = 87%

45. (c) :

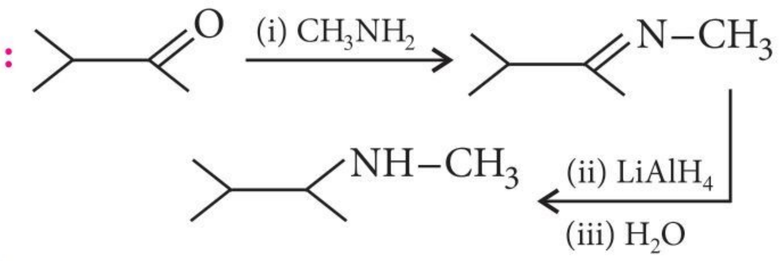
	$Na_2SO_4 \longrightarrow$	$2Na^+ +$	SO_4^{2-}
Mol before dissociation	1	0	0
Mol after dissociation	1 – α	2α	α

$i = 1 - \alpha + 2\alpha + \alpha = 1 + 2\alpha$

46. (d): Aldehydes and ketones do not give addition reaction with $HCl_{(aq)}$.

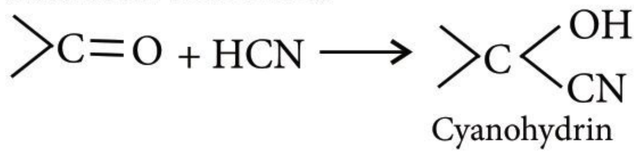
47. (a) : Since the cyanohydrin produced is a chiral compound, *i.e.*, optically active, we obtain both enantiomeric forms of the product. Thus, product as a whole would be racemic mixture.

48. (a) :



49. (d)

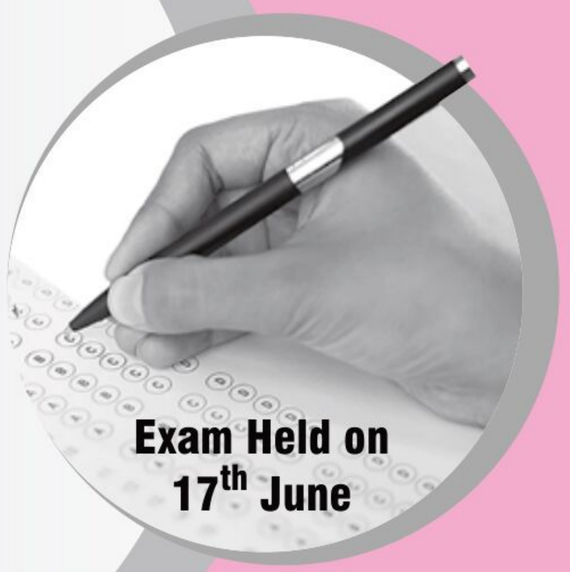
50. (c) : Carbonyl compounds undergo nucleophilic addition reaction.



Cyanohydrin

SOLVED PAPER **2022**

Karnataka CET



(MULTIPLE CHOICE QUESTIONS)

1. A first order reaction is half completed in 45 min. How long it need 99.9% of the reaction to be completed?
(a) 10 hours (b) 20 hours
(c) 5 hours (d) 7.5 hours

2. The rate of the reaction:
$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$
is given by the equation
Rate = $k[CH_3COOC_2H_5][NaOH]$
If concentration is expressed in mol L^{-1}, the unit of k is
(a) L mol^{-1} s^{-1} (b) s^{-1}
(c) mol^{-2} L^2 s^{-1} (d) mol L^{-1} s^{-1}

3. Colloidal solution commonly used in the treatment of skin disease is
(a) colloidal gold (b) colloidal antimony
(c) colloidal sulphur (d) colloidal silver.

4. Specific conductance of 0.1 M HNO_3 is 6.3×10^{-2} ohm^{-1} cm^{-1}. The molar conductance of the solution is
(a) 6.300 ohm^{-1} cm^2 mol^{-1}
(b) 63.0 ohm^{-1} cm^2 mol^{-1}
(c) 630 ohm^{-1} cm^2 mol^{-1}
(d) 315 ohm^{-1} cm^2 mol^{-1}

5. For spontaneity of a cell, which is correct?
(a) ΔG = +ve, ΔE = +ve
(b) ΔG = –ve
(c) $\Delta G = 0$, $\Delta E = 0$
(d) ΔG = –ve, $\Delta E = 0$

6. For n^{th} order of reaction, half-life period is directly proportional to
(a) a^{n-1} (b) a^{1-n} (c) $\frac{1}{a^{n-1}}$ (d) $\frac{1}{a^{1-n}}$

7. Half-life of a reaction is found to be inversely proportional to the fifth power of its initial concentration, the order of reaction is
(a) 5 (b) 6 (c) 3 (d) 4

8. The strong reducing property of hypophosphorous acid is due to
(a) two P – H bonds
(b) presence of phosphorus in its highest oxidation state
(c) its concentration
(d) the positive valency of phosphorus.

9. A transition metal exists in its highest oxidation state. It is expected to behave as
(a) an oxidising agent
(b) a reducing agent
(c) a chelating agent
(d) a central metal in a co-ordination compound.

10. What will be the value of x in Fe^{x+}, if the magnetic moment, $\mu = \sqrt{24}$ BM ?
(a) 0 (b) +1 (c) +2 (d) +3

11. Which can adsorb larger volume of hydrogen gas?
(a) Finely divided platinum
(b) Colloidal $Fe(OH)_3$
(c) Finely divided nickel
(d) Colloidal solution of palladium

12. The property of halogens which is not correctly matched is
(a) I > Br > Cl > F (density)
(b) F > Cl > Br > I (electron gain enthalpy)
(c) F > Cl > Br > I (ionisation enthalpy)
(d) F > Cl > Br > I (electronegativity)

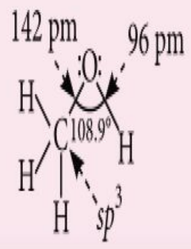
13. Which noble gas has least tendency to form compounds?
(a) Ar (b) Kr (c) He (d) Ne

CONCEPT MAP

ALCOHOLS, PHENOLS AND ETHERS

Alcohols

$(C_nH_{2n+1}OH)$



Preparation

- $RX + KOH_{(aq.)} \rightarrow ROH + KX$
- $C{=}C$ (Alkene) $\xrightarrow[\text{(Markovnikov's addition)}]{\text{Conc. } H_2SO_4/H_2O}$ RCH_2OH
  - (i) B_2H_6 in THF
  - (ii) H_2O_2, OH^- (Anti-Markovnikov's addition)
- HCHO or $RCHO$ or $R_2C{=}O$ (Carbonyl compounds) $\xrightarrow[\text{Grignard's reagent}]{\text{Reduction}}$
  - H_2/Pt or Pd or Ni → RCH_2OH (1° Alcohol)
  - $NaBH_4$ or $LiAlH_4$ or Na/C_2H_5OH → $R{-}CH(OH){-}R$ (2° Alcohol)
  - (i) $RMgX$/Dry ether, (ii) H_2O/H^+ → $R_3C{-}OH$ (3° Alcohol)
- $RCOOH$ (Carboxylic acid) $\xrightarrow[(ii)\ H_3O^+]{(i)\ LiAlH_4 \text{ or } B_2H_6/\text{ether}}$ RCH_2OH

Physical Properties

$$\text{B.pt.} \propto \text{No. of C-atoms} \propto \frac{1}{\text{Branching}}$$

$$\text{Solubility} \propto \frac{1}{\text{Size}} \propto \text{Branching}$$

Distinction Tests

- **Dichromate test (oxidation) :** 1° alcohol → Acid with same number of C-atoms; 2° alcohol → Ketone with same number of C-atoms; 3° alcohol → No reaction under normal conditions.
- **Victor Meyer's test :** 1° alcohol → Blood red colour; 2° alcohol → Blue colour; 3° alcohol → Colourless.
- **Lucas test :** 1° alcohol → No turbidity; 2° alcohol → Turbidity in 5 minutes; 3° alcohol → Turbidity appears immediately.

Some Important Alcohols

- **Methanol :** It is prepared by catalytic hydrogenation of carbon monoxide or water gas. It is used as a solvent, preservative, substitute for petrol, etc.
- **Ethanol :** It is prepared by the hydration of ethene or by the fermentation of molasses. It is used as an antiseptic, power alcohol, in beverages, etc.

Chemical Properties

- **Cleavage of O–H bond :** Ease of reaction depends on stability of alkoxide ion.
  Acidity : Phenols > Water > 1° alcohol > 2° alcohol > 3° alcohol
  $ROH \xrightarrow{\text{Metallic Na}} \underset{\text{Sodium Alkoxide}}{RO^-Na^+}$
- **Cleavage of C–OH bond :** Ease of reaction depends on stability of carbocations.
  Order of reactivity : 3° alcohol > 2° alcohol > 1° alcohol
  $ROH \xrightarrow[ZnCl_2]{HX} \underset{\text{Alkyl halide}}{RX}$
- **Reactions involving whole alcohol molecule :**

Dehydration : $R{-}OH + \text{conc. } H_2SO_4$
- 443 K → $C{=}C$
- 413 K → ROR
- 383 K → $RO{-}SO_2OH$

$R{-}OH + Al_2O_3$
- 513 K → ROR
- 633 K → $C{=}C$

Oxidation : Alcohol $\xrightarrow{[O]}$ Aldehyde/Ketone $\xrightarrow{[O]}$ Carboxylic acid

$RCH_2OH \xrightarrow[\text{Acidic } K_2Cr_2O_7]{\text{Alk. } KMnO_4} RCHO \xrightarrow{[O]} RCOOH$ (1° alcohol)

$R_2CHOH \xrightarrow{[O]} R_2C{=}O \xrightarrow{[O]} RCOOH$ (2° alcohol)

$R_3COH \xrightarrow{[O]} R_2C{=}O \xrightarrow{[O]} RCOOH$ (3° alcohol)

Dehydrogenation : 1° alcohol $\xrightarrow{Cu/273\ K}$ Aldehyde

2° alcohol $\xrightarrow{Cu/273\ K}$ Ketone

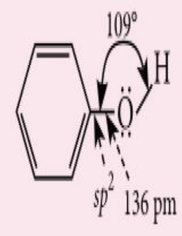
Dehydration : 3° alcohol $\xrightarrow{Cu/273\ K}$ $C{=}C$

- **Esterification**

$RO{-}H + R'COOH \rightleftharpoons R'{-}C(=O){-}OR + H_2O$ (H^+)

Phenols

(C_6H_5OH)



Preparation

- $C_6H_5SO_3H \xrightarrow[-H_2O]{NaOH} C_6H_5SO_3Na \xrightarrow[573\text{–}623\ K,\ -Na_2SO_3,\ -H_2O]{2NaOH} C_6H_5O^-Na^+ \xrightarrow[-NaCl]{\text{dil. HCl}}$
- $C_6H_5N_2^+Cl^- + H_2O \xrightarrow[-N_2,\ -HCl]{\text{dil. } H_2SO_4,\ \Delta}$
- $C_6H_5Cl + NaOH \xrightarrow[-NaCl,\ -H_2O]{623\ K,\ 320\ atm} C_6H_5O^-Na^+ \xrightarrow[-NaCl]{\text{dil. HCl}}$
- $C_6H_5CH(CH_3)_2$ (Cumene) $\xrightarrow[2.\ H^+,\ H_2O]{1.\ O_2}$

→ C_6H_5OH Phenol

Physical Properties

- Pure phenols are colourless liquids or crystalline solids.
- Form intermolecular hydrogen bonds with water. Hence, soluble in water.

Chemical Properties

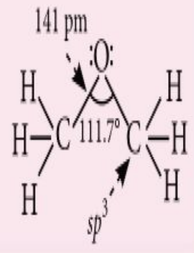
- Electrophilic substitution of phenols : Halogenation, sulphonation, nitration, Friedel–Crafts alkylation, etc. occur at *o*- and *p*- positions due to activating effect of –OH group.

Tests to Distinguish Phenols from Alcohols

- **$FeCl_3$ test :** Gives violet colour
- **$Br_2 - H_2O$ test :** Gives white ppt.
- **Liebermann's nitroso test :** Gives blue colour which turns red on dilution
- **Azo dye test :** Gives orange colour

Ethers

$(C_nH_{2n+2}O \text{ where } n > 1)$



Classification

- **Simple or symmetrical :** Same alkyl groups are attached to oxygen, *ROR*.
- **Mixed or unsymmetrical :** Different alkyl groups are attached to oxygen, *ROR′*.
- **Aliphatic ethers :** *R* and *R′* both are alkyl groups.
- **Aromatic ethers :** Either one or both *R* and *R′* are aryl groups.

Preparation

- $2ROH \xrightarrow[\text{or } Al_2O_3,\ 523\ K]{\text{conc. } H_2SO_4,\ 413\ K} ROR$ (Ether)
- $RX + RONa \xrightarrow[-NaX]{\Delta} ROR$ (Ether) (Williamson synthesis)

- Williamson synthesis involves S_N2 mechanism in case of 1° alkyl halides.
- In the case of 2° and 3° alkyl halides, elimination takes place.
- Dehydration of alcohols for the formation of ethers follows the order: 1° > 2° > 3°

Physical Properties

- Dipolar due to slightly polar C–O bonds.
- B.pts. of ethers are lower than isomeric alcohols due to lack of hydrogen bonding.
- Solubility in water $\propto \frac{1}{\text{Molecular mass}}$ (Soluble due to formation of H-bonds with water)
- Fairly soluble in organic solvents.
- Lighter than water.

Chemical Properties

- **Reaction of ethereal oxygen:** $ROR + HCl(\text{conc.}) \rightarrow \left[R_2\overset{+}{O}{-}H\right]Cl^-$
- **Cleavage of C–O bond:** $R{-}OR + HX \xrightarrow{373\ K} R{-}OH + R{-}X$
  - In case of alkyl aryl ethers, phenol and an alkyl halide are obtained.
  $ROR + H_2O \xrightarrow{\text{dil. } H_2SO_4} 2R{-}OH$
  $ROR + PCl_5 \xrightarrow{\Delta} 2R{-}Cl + POCl_3$
- **Reactions involving alkyl group:**
  - Formation of peroxides with air and light.
  - Substitution products obtained on halogenation.
- **Electrophilic substitution reaction:**
  Aryl alkyl ethers give *o*- and *p*- substituted products due to +*R* effect of alkoxy group (–*OR*).

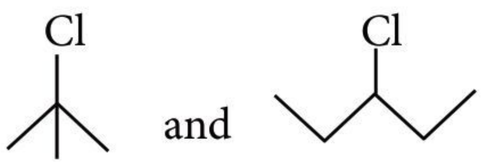
Uses

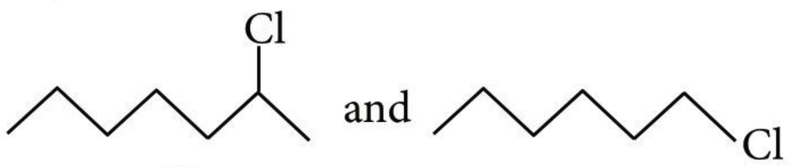
Ethers are used as industrial solvents, heat transfer medium (diphenyl ether), flavouring agents and in perfumes.

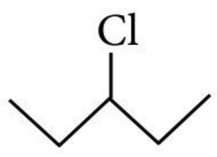
14. $(NH_4)_2Cr_2O_7$ on heating liberates a gas. The same gas will be obtained by
(a) treating H_2O_2 with $NaNO_2$
(b) treating Mg_3N_2 with H_2O
(c) heating NH_4NO_3
(d) heating NH_4NO_2

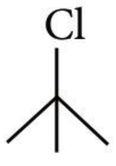
15. The complex hexaamineplatinum(IV) chloride will give _____ number of ions on ionisation.
(a) 3 (b) 2 (c) 5 (d) 4

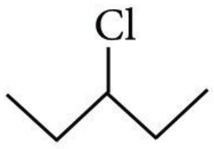
16. In the following pairs of halogen compounds, which compound undergoes faster S_N1 reaction?

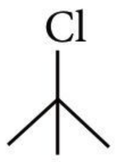
(i)  and

(ii)  and

(a) (i)  ; (ii) 

(b) (i)  ; (ii) 

(c) (i)  ; (ii) 

(d) (i)  ; (ii) 

17. The only lanthanoid which is radioactive
(a) promethium (b) praseodymium
(c) lanthanum (d) cerium.

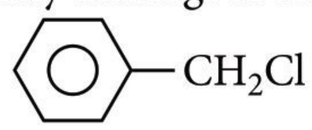
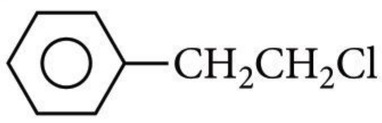
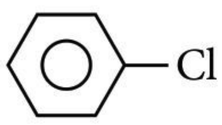
18. All Cu(II) halides are known, except iodide, the reason for it is that
(a) Cu^{2+} has much more negative hydration enthalpy
(b) Cu^{2+} ion has smaller size
(c) iodide is bulky ion
(d) Cu^{2+} oxidises iodide to iodine.

19. The correct IUPAC name of *cis*-platin is
(a) diamminedichloridoplatinum(0)
(b) dichloridodiammineplatinum(IV)
(c) diamminedichloridoplatinum(II)
(d) diamminedichloridoplatinum(IV).

20. Crystal Field Splitting Energy (CFSE) for $[CoCl_6]^{4-}$ is 18000 cm^{-1}. The Crystal Field Splitting Energy (CFSE) for $[CoCl_4]^{2-}$ will be
(a) 8000 cm^{-1} (b) 10,000 cm^{-1}
(c) 18000 cm^{-1} (d) 16000 cm^{-1}

21. The major product obtained when ethanol is heated with excess of conc. H_2SO_4 at 443 K is
(a) ethane (b) methane
(c) ethene (d) ethyne.

22. Among the following, the products formed by the reaction of anisole with HI are
(a) benzene + methanol
(b) phenol + methane
(c) phenol + iodomethane
(d) sodium phenate + methanol.

23. Which one of the following chlorohydrocarbon readily undergoes solvolysis?
(a)  (b) 
(c) $CH_2=CHCl$ (d) 

24. Identify the products *A* and *B* in the reactions:
$R-X + AgCN \longrightarrow A + AgX$
$R-X + KCN \longrightarrow B + KX$
(a) $A = RNC$, $B = RCN$
(b) $A = RNC$; $B = RNC$
(c) $A = R-CN$; $B = RCN$
(d) $A = RCN$; $B = RNC$

25. An organic compound with molecular formula C_7H_8O dissolves in NaOH and gives a characteristic colour with $FeCl_3$. On treatment with bromine, it gives a tribromo derivative $C_7H_5OBr_3$. The compound is
(a) *m*-cresol (b) *p*-cresol
(c) benzyl alcohol (d) *o*-cresol.

26. In Kolbe's reaction the reacting substances are
(a) sodium phenate and CCl_4
(b) phenol and $CHCl_3$
(c) sodium phenate and CO_2
(d) phenol and CCl_4.

27. In carbylamine test for primary amines the resulting foul smelling product is
(a) CH_3NC (b) $COCl_2$
(c) CH_3NCl_2 (d) CH_3CN

28. Ethanoic acid undergoes Hell—Volhard—Zelinsky reaction but methanoic acid does not because of
(a) absence of α-H atom in ethanoic acid
(b) higher acidic strength of ethanoic acid than methanoic acid
(c) presence of α-H atom in methanoic acid
(d) presence of α-H atom in ethanoic acid.

29. The general name of the compound formed by the reaction between aldehyde and alcohol is
(a) glycol (b) acetate
(c) ester (d) acetal.

30. Reaction by which benzaldehyde cannot be prepared is
(a) Toluene $\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } CrO_2Cl_2 \text{ in } CS_2}$
(b) Benzoyl chloride + $H_2 \xrightarrow[\Delta]{Pd\text{-}BaSO_4}$
(c) Benzene + CO + HCl $\xrightarrow{\text{anhydrous } AlCl_3}$
(d) Benzoic acid $\xrightarrow{\text{Zn-Hg and conc. HCl}}$

31. The test to differentiate between pentan-2-one and pentan-3-one is
(a) Fehling's test (b) iodoform test
(c) Baeyer's test (d) Benedict's test.

32. A secondary amine is
(a) compound with an NH_2 group on the carbon atom in number 2 position
(b) a compound in which 2 of the hydrogen of NH_3 have been replaced by organic groups
(c) an organic compound with two NH_2 groups
(d) a compound with two carbon atoms and an NH_2 group.

33. Which of the following is correctly matched?
(a) Bakelite – Novolac
(b) Polyester – tetrafluoroethene
(c) Nylon – acrylonitrile
(d) Teflon – caprolactum

34. Which institute has approved the emergency use of 2-deoxy-*D*-glucose as additive therapy for covid-19 patients?
(a) Ministry of Health and Family Welfare
(b) Drug Controller General of India
(c) Indian Council of Medical Research
(d) World Health Organisation

35. A nucleic acid, whether DNA or RNA gives on complete hydrolysis, two purine bases, two pyrimidine bases, a pentose sugar and phosphoric acid. Nucleotides which are intermediate products in the hydrolysis contain
(a) purine or pyrimidine base and *ortho*-phosphoric acid
(b) purine or pyrimidine base, a pentose sugar and *ortho*-phosphoric acid
(c) purine or pyrimidine base and pentose sugar
(d) a purine base, pentose sugar and *ortho*-phosphoric acid.

36. Which is most viscous?
(a) Ethylene glycol (b) Glycerol
(c) Methanol (d) Ethanol

37. The volume of 2.8 g of CO at 27°C and 0.821 atm pressure is (R = 0.08210 lit atm K^{-1} mol^{-1})
(a) 3 litres (b) 30 litres
(c) 0.3 litres (d) 1.5 litres

38. The work done when 2 moles of an ideal gas expands reversibly and isothermally from a volume of 1 L to 10 L at 300 K is (R = 0.0083 kJ K mol^{-1})
(a) 0.115 kJ (b) 58.5 kJ
(c) 11.5 kJ (d) 5.8 kJ

39. An aqueous solution of alcohol contains 18 g of water and 414 g of ethyl alcohol. The mole fraction of water is
(a) 0.7 (b) 0.9 (c) 0.1 (d) 0.4

40. If wavelength of photon is 2.2×10^{-11}m and $h = 6.6 \times 10^{-34}$ J s, then momentum of photon
(a) 1.452×10^{-44} kg m s^{-1}
(b) 6.89×10^{-43} kg m s^{-1}
(c) 3×10^{-23} kg m s^{-1}
(d) 3.33×10^{-22} kg m s^{-1}

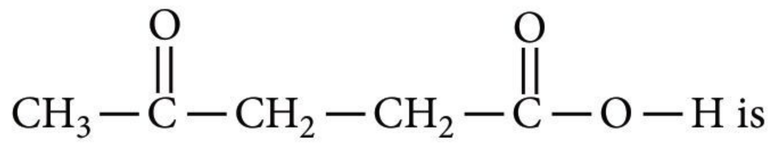
41. Elements X, Y and Z have atomic numbers 19, 37 and 55 respectively. Which of the following statements is true about them?
(a) Z would have the highest ionization potential.
(b) Y would have the highest ionization potential.
(c) Their ionization potential would increase with increasing atomic number.
(d) Y would have an ionization potential between those of X and Z.

42. In oxygen and carbon molecule the bonding is
(a) $O_2 : 1\sigma, 1\pi$; $C_2 : 0\sigma, 2\pi$
(b) $O_2 : 0\sigma, 2\pi$; $C_2 : 2\sigma, 0\pi$
(c) $O_2 : 1\sigma, 1\pi$; $C_2 : 1\sigma, 1\pi$
(d) $O_2 : 2\sigma, 0\pi$; $C_2 : 0\sigma, 2\pi$

43. Amphoteric oxide among the following
(a) Ag_2O (b) SnO_2 (c) BeO (d) CO_2

44. Which property of CO_2 makes it biologically and geo-chemically important?
(a) Its low solubility in water.
(b) Its high compressibility.
(c) Its acidic nature.
(d) Its colourless and odourless nature.

45. The IUPAC name for



(a) 1-carboxybutan-3-one
(b) 4-oxopentanoic acid
(c) 1-hydroxypentane-1,4-dione
(d) 1,4-dioxopentanol

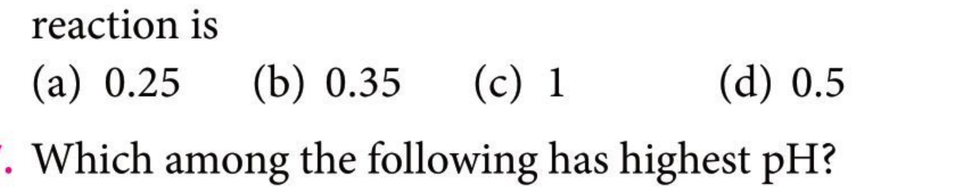
46. 1 mole of HI is heated in a closed container of capacity of 2 L. At equilibrium half a mole of HI is dissociated. The equilibrium constant of the reaction is
(a) 0.25 (b) 0.35 (c) 1 (d) 0.5

47. Which among the following has highest pH?
(a) 1 M H_2SO_4 (b) 0.1 M NaOH
(c) 1 M HCl (d) 1 M NaOH

48. In which of the following compounds, an element exhibits two different oxidation states?
(a) N_2H_4 (b) N_3H
(c) NH_2CONH_2 (d) NH_4NO_3

49. Which of the following hydrides is electron deficient?
(a) CH_4 (b) B_2H_6 (c) NaH (d) CaH_2

50. Identify *A* and *B* in the reaction



(a) *A* : $CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$,
B : $CH_3-CH_2-CH_2-I$

(b) *A* : $CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3$,
B : $CH_3-\underset{\displaystyle I}{\underset{|}{CH}}-CH_3$

(c) *A* : $CH_3-CH_2-CH_2-Br$,
B : $CH_3-CH_2-CH_2-I$

(d) *A* : $CH_3-CH_2-CH_2-Br$,
B : $CH_3-\underset{\displaystyle I}{\underset{|}{CH}}-CH_3$

51. Vacant space in body centred cubic lattice unit cell is about
(a) 23% (b) 46% (c) 32% (d) 10%

52. How many number of atoms are there in a cube based unit cell, having one atom on each corner and 2 atoms on each body diagonal of cube?
(a) 4 (b) 9 (c) 8 (d) 6

53. Which of the following is not true about the amorphous solids?
(a) Amorphous solids can be moulded by heating.
(b) They are anisotropic in nature.
(c) On heating they may become crystalline at certain temperature.
(d) They may become crystalline on keeping for long time.

54. Which of the following colligative properties can provide molar mass of proteins, polymers and colloids with greater precision?
(a) Depression in freezing point
(b) Osmotic pressure
(c) Relative lowering of vapour pressure
(d) Elevation in boiling point

55. In fuel cells, _____ are used as catalysts.
(a) zinc-mercury (b) lead-manganese
(c) platinum-palladium
(d) nickel-cadmium

56. The molar conductivity is maximum for the solution of concentration
(a) 0.005 M (b) 0.001 M
(c) 0.004 M (d) 0.002 M.

57. Alkali halides do not show dislocation defect because
(a) cations and anions have almost equal size
(b) there is large difference in size of cations and anions
(c) cations and anions have low co-ordination number
(d) anions cannot be accommodated in vacant spaces.

58. Solubility of gas in a liquid increases with
(a) increase of *P* and decrease of *T*
(b) decrease of *P* and decrease of *T*
(c) increase of *P* and increase of *T*
(d) decrease of *P* and increase of *T*.

59. The rise in boiling point of a solution containing 1.8 g of glucose in 100 g of solvent is 0.1°C. The molal elevation constant of the liquid is
(a) 2 K kg/mol (b) 10 K kg/mol
(c) 0.1 K kg/mol (d) 1 K kg/mol

60. If 3 g of glucose (molar mass = 180 *g*) is dissolved in 60 g of water at 15°C, the osmotic pressure of the solution will be

(a) 6.57 atm (b) 5.57 atm

(c) 0.34 atm (d) 0.65 atm.

SOLUTIONS

1. (d) : For first order reaction,

$$t_{1/2} = \frac{0.693}{k} \Rightarrow k = \frac{0.693}{t_{1/2}} = \frac{0.693}{45} \text{ min}^{-1}$$

$$k = \frac{2.303}{t}\log\left(\frac{a}{a-x}\right)$$

$$\frac{0.693}{45} = \frac{2.303}{t}\log\left(\frac{100}{0.1}\right) = \frac{2.303\times 3}{t}$$

$$t = \frac{2.303\times 3\times 45}{0.693}\text{ min} = 448.6\text{ min}$$

$$= \frac{448.6}{60}\text{ hours} = 7.5\text{ hours}$$

2. (a) : The rate of the given reaction is expressed in mol L^{-1} s^{-1}. Hence,

mol L^{-1} s^{-1} = k [mol L^{-1}]^2

$$k = \frac{\text{mol L}^{-1}\ \text{s}^{-1}}{\text{mol}^2\ \text{L}^{-2}} = \text{mol}^{-1}\ \text{L s}^{-1} \text{ or L mol}^{-1}\ \text{s}^{-1}$$

3. (c) : Colloidal sol of sulphur is used in the treatment of skin diseases due to its large surface area.

4. (c) : $\Lambda_m = \frac{\kappa\times 1000}{M}$

$$= \frac{6.3\times 10^{-2}\ \text{ohm}^{-1}\ \text{cm}^{-1}\times 1000}{0.1\ \text{mol}\ \text{cm}^{-3}}$$

$$= 630\ \text{ohm}^{-1}\ \text{cm}^2\ \text{mol}^{-1}$$

5. (b) : For spontaneity of a cell,

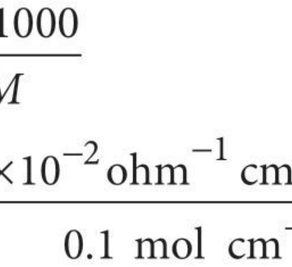
ΔG = –ve, E_{cell} = +ve

6. (b,c) : For n^{th} order reaction, $t_{1/2} \propto \frac{1}{a^{n-1}} \propto a^{1-n}$

7. (b) : For n^{th} order : $t_{1/2} \propto \frac{1}{a^{n-1}} \propto \frac{1}{a^5}$

$n - 1 = 5 \Rightarrow n = 5 + 1 = 6$

8. (a) : H_3PO_2 is reducing in nature due to the presence of two P — H bonds.



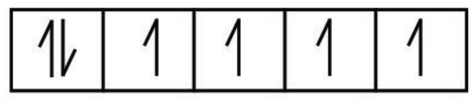
9. (a) : If a transition metal is present in its highest oxidation state, it can only accept electrons thus, it will act as an oxidising agent.

10. (c) : $\mu = \sqrt{24}$ BM $= \sqrt{n(n+2)}$

$n(n + 2) = 24 \Rightarrow n = 4$

n = Number of unpaired electrons = 4

Fe : [Ar] $3d^6 4s^2$

Fe^{2+} : [Ar] 

Thus, Fe^{2+} has 4 unpaired electrons.

11. (d) : Colloidal solution of palladium can adsorb largest volume of hydrogen gas as the surface area of palladium is maximum in its colloidal solution.

12. (b) : Electron gain enthalpy order for halogens is as follows : Cl > F > Br > I

13. (c)

14. (d) : $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2\uparrow + 4H_2O$

Hence, N_2 gas is liberated on heating $(NH_4)_2Cr_2O_7$.

$H_2O_2 + NaNO_2 \longrightarrow NaNO_3 + H_2O$

$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$

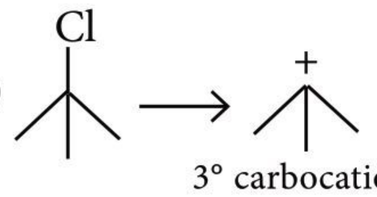
$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

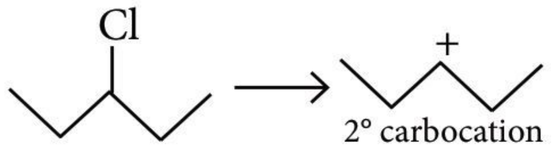
15. (c) : $[Pt(NH_3)_6]Cl_4 \longrightarrow [Pt(NH_3)_6]^{4+} + 4Cl^-$

The given complex provide 5 ions on ionisation.

16. (d) : (i)

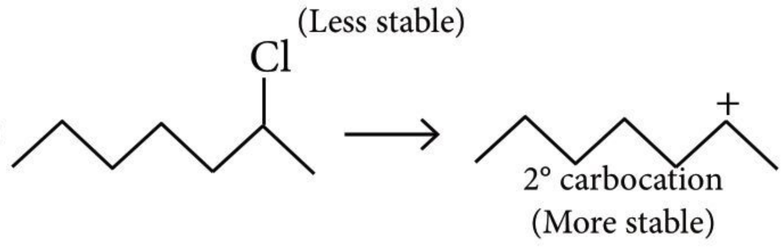


3° carbocation
(More stable)



2° carbocation
(Less stable)

(ii)



2° carbocation
(More stable)

1° carbocation
(Less stable)

Higher the stability of the carbocation formed, higher will be the rate of S_N1 reaction.

17. (a) : Promethium is the only lanthanoid that exhibits radioactivity.

18. (d) : Cu^{2+} oxidises I^- to I_2 easily hence, copper iodide is not known.

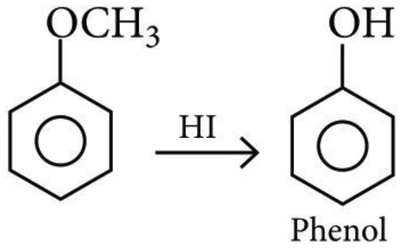
19.(c) : *Cis*-platin is $[Pt(NH_3)_2Cl_2]$.
The IUPAC name is diamminedichloridoplatinum(II)

20.(a) : Δ_o for $[CoCl_6]^{4-} = 18000\ cm^{-1}$

$$\Delta_t = \frac{4}{9} \times \Delta_o = \frac{4}{9} \times 18000\ cm^{-1} = 8000\ cm^{-1}$$

21.(c) : $CH_3CH_2OH \xrightarrow[443\ K]{\text{conc. } H_2SO_4} \underset{\text{Ethene}}{CH_2 = CH_2}$

22.(c) :



Phenol + CH_3I (Iodomethane)

23.(a) : As benzyl carbocation is the most stable due to resonance.

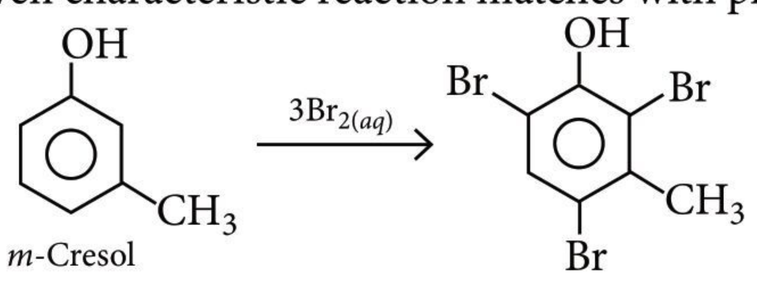
24.(a) : $R - X + AgCN \longrightarrow RNC + AgX$

$R - X + KCN \longrightarrow RCN + KX$

KCN is ionic and dissociates as K^+ and CN^- ions while AgCN is mainly covalent and nitrogen is free to donate electron pair to the electrophilic carbon.

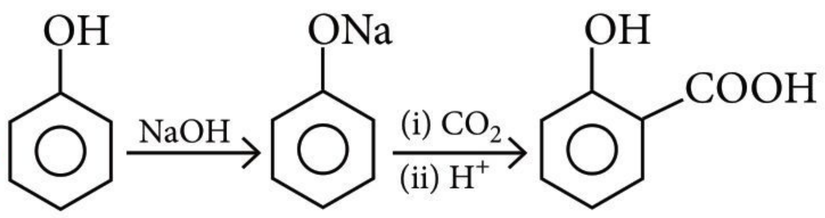
25.(a) : $C_7H_8O \xrightarrow[\text{(ii) gives colour with } FeCl_3]{\text{(i) dissolves in NaOH}}$
(iii) with bromine it gives tribromo derivative

The given characteristic reaction matches with phenol.



m-Cresol

26.(c) :



27.(a) : Isocyanides are foul smelling products formed on carbylamine reaction. The reaction equation shown below depicts a general carbylamine reaction.

$$RNH_2 \xrightarrow[KOH]{CHCl_3} \underset{\text{(Isocyanide)}}{RNC} + KCl + H_2O$$

28.(d) : $CH_3COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Br_2/\text{Red P}} \underset{Br}{CH_2(Br)-COOH}$
(Hell—Volhard—Zelinsky reaction)

29.(d)

30.(d) : Zn-Hg/conc. HCl is used to reduce $>C=O$ to $>CH_2$ but it cannot reduce –COOH group.

31.(b) : $CH_3 - \underset{\underset{O}{\|}}{C} - CH_2CH_2CH_3$
Pentan-2-one

$CH_3 - CH_2 - \underset{\underset{O}{\|}}{C} - CH_2CH_3$
Pentan-3-one

Iodoform test is given by ketones containing $CH_3 - \underset{\underset{O}{\|}}{C} -$ group.

32.(b) : $\underset{\text{Secondary amine}}{R - NH - R}$

33.(a) : A linear product of phenol-formaldehyde polymer is novolac and novolac on heating with formaldehyde undergoes cross linking to form bakelite.

34.(b)

35.(b) : A molecule of nucleotide consists of a nitrogen containing base, a phosphate group and a sugar.

36.(b) : Since glycerol has three — OH groups, it is most viscous.

37.(a) : $n = \frac{2.8\ g}{28\ g\ mol^{-1}} = 0.1\ mol$

From ideal gas equation, $PV = nRT$

$$V = \frac{nRT}{P}$$

$$= \frac{0.1\ mol \times 0.08210\ L\ atm\ mol^{-1}\ K^{-1} \times 300\ K}{0.821\ atm} = 3\ L$$

38.(c) : For an isothermal reversible expansion of an ideal gas work done is calculated as :

$$w = -2.303nRT \log\left(\frac{V_2}{V_1}\right)$$

$$= -2.303 \times 2 \times 0.0083\ kJ \times 300 \times \log\left(\frac{10}{1}\right) = -11.5\ kJ$$

(Note : The amount of work done is 11.5 kJ.)

39.(c) : Moles of water $= \frac{18\ g}{18\ g\ mol^{-1}} = 1\ mol$

Moles of ethyl alcohol $= \frac{414\ g}{46\ g\ mol^{-1}} = 9\ mol$

Mole fraction of water $= \frac{\text{Moles of water}}{\text{Total number of moles}}$

$$= \frac{1\ mol}{(1+9)\ mol} = 0.1$$

40.(c) : $\lambda = 2.2 \times 10^{-11}$ m, $h = 6.6 \times 10^{-34}$ J s or $6.6 \times 10^{-34}\ kg\ m^2\ s^{-1}$

$$p = \frac{h}{\lambda} = \frac{6.6 \times 10^{-34}}{2.2 \times 10^{-11}} = 3 \times 10^{-23}\ kg\ m\ s^{-1}$$

41.(d)

42.(a) : O_2 has 1 σ and 1 π bond but C_2 molecule has 2π bonds.

43.(c) : BeO is an amphoteric oxide.

44.(a) : CO_2 forms carbonic acid with water which dissociates to give HCO_3^- ions.
H_2CO_3/HCO_3^- is a buffer system which helps in maintaining pH of blood.

45.(b)

46.(a) :

	$2HI \rightleftharpoons$	H_2	+	I_2
Initial moles	1	0		0
At eqm.	$1-\frac{1}{2}=\frac{1}{2}$	$\frac{1}{4}$		$\frac{1}{4}$

$$[HI]=\frac{1}{2}\times\frac{1}{2}\ \text{mol/L}$$

$$[H_2]=\frac{1}{4}\times\frac{1}{2}\ \text{mol/L}\ ;\ [I_2]=\frac{1}{4}\times\frac{1}{2}\ \text{mol/L}$$

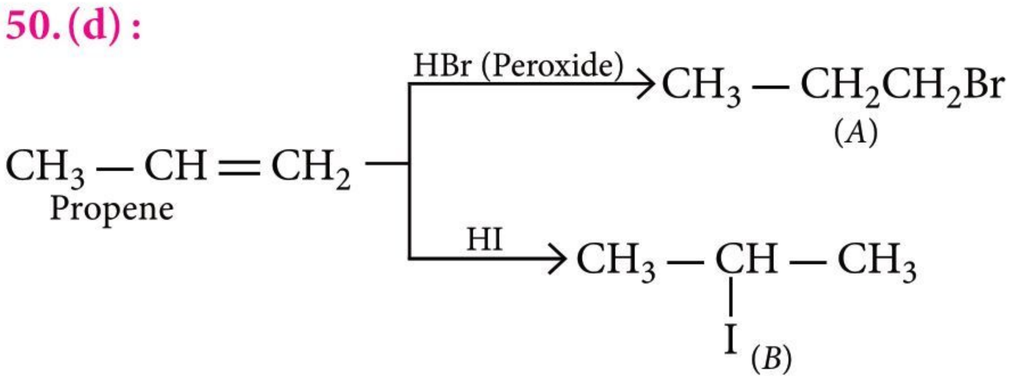
$$K_c=\frac{[H_2][I_2]}{[HI]^2}=\frac{\frac{1}{8}\times\frac{1}{8}}{\left(\frac{1}{4}\right)^2}=\frac{4\times4}{8\times8}=\frac{1}{4}=0.25$$

47.(d) : H_2SO_4 and HCl are acids, so pH will be lower than 7. Since 1 mole of NaOH dissociates to give 1 mole of Na^+ and OH^- ions in aqueous solution.
NaOH = $[OH^-]$ = 0.1
pOH = $-\log[OH^-] = -\log[0.1] = 1$
pH = 14 – 1 = 13
For 1 M NaOH, $[OH^-]$ = 1
pOH = $-\log[OH^-] = 0 \Rightarrow$ pH = 14

48.(d) : $NH_4^+\ NO_3^-$
Let oxidation state of N be x in NH_4^+ then
$x + 4(+1) = +1 \Rightarrow x = -3$
In NO_3^-, $x + 3(-2) = -1$ then $x = +5$

49.(b)

50.(d) :



51.(c) : Packing efficiency of *bcc* is 68%.
So the vacant space is 32%.

52.(b) : 1 atom at each corner means it has $1/8^{th}$ portion of an atoms.

$$\text{Number of atoms per unit cell} = 8\times\frac{1}{8}=1$$

The total atoms at body diagonal = 4 × 2 = 8
Total atoms in cubic unit cell = 8 + 1 = 9

53.(b) : Amorphous solids are isotropic in nature.

54.(b)

55.(c) : In a fuel cell, the platinum-palladium catalysts facilitates the reaction between oxygen and hydrogen, thus increasing the rate of electrode reactions.

56.(b) : $\Lambda_m=\frac{\kappa\times1000}{c}$. Thus, $\Lambda_m\propto\frac{1}{c}$
Lower the value of concentration, higher is the molar conductivity.

57.(a)

58.(a) : According to Henry's law,

$$S_g = K_H P_g \qquad S_g \propto P_g$$

S_g = solubility of gas
P_g = partial pressure of gas
On increasing temperature, solubility of gases decreases, as on increasing temperature, kinetic energy of gas increases.

59.(d) : $\Delta T_b = iK_b\ m$
For glucose, i = 1

$$m=\frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}}$$

$$\text{Moles of glucose} = \frac{1.8\ \text{g}}{180\ \text{g mol}^{-1}} = 0.01\ \text{mol}$$

Mass of solvent = 100 g = 0.1 kg

$$m=\frac{0.01\ \text{mol}}{0.1\ \text{kg}}=0.1\ \text{mol kg}^{-1}$$

$\Delta T_b = 0.1 = 1 \times 0.1 \times K_b \Rightarrow K_b = 1$ K kg/mol

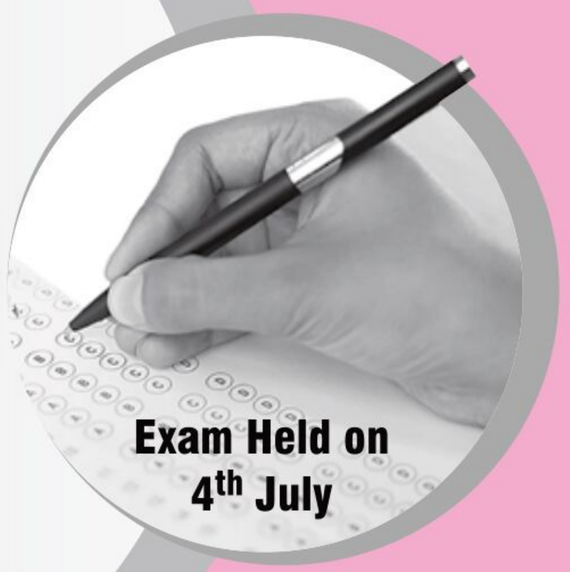
60.(a) : Osmotic pressure, $(\pi) = CRT$

$$C=\frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}}=\frac{3/180}{60\times10^{-3}}$$

C = 0.277 mol/kg
π = 0.277 mol/kg × 288 K × 0.0821 L atm mol^{-1} K^{-1}
= 6.55 atm ≈ 6.57 atm.

SOLVED PAPER 2022

Kerala PET (KEAM)



1. The product formed, when benzene diazonium fluoroborate is heated with aqueous sodium nitrite solution in the presence of copper is
(a) fluorobenzene (b) benzene
(c) phenol (d) *p*-nitrophenol
(e) nitrobenzene.

2. Which one of the following is a polysaccharide?
(a) Glycogen (b) Lactose
(c) Maltose (d) Sucrose
(e) Glucose

3. Which of the following is added to commercial salt to control hypothyroidism?
(a) Magnesium iodide (b) Potassium iodide
(c) Sodium iodide (d) Calcium iodide
(e) Lithium iodide

4. Conveyor belt is manufactured from
(a) buna-S (b) neoprene
(c) PVC (d) teflon
(e) glyptal.

5. Which one of the following is a non-narcotic analgesics?
(a) Morphine (b) Codeine
(c) Paracetamol (d) Heroin
(e) Bithional

6. The primary precursor of photochemical smog that can be metabolised by plants such as Juniparus and Pyrus, is
(a) nitrogen dioxide (b) ozone
(c) PAN (d) carbon dioxide
(e) sulphur dioxide.

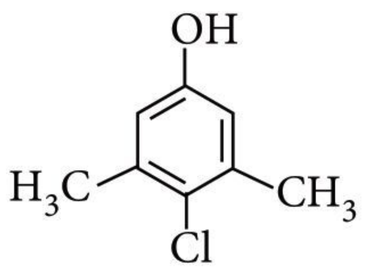
7. Which one of the following contains the highest number of oxygen atoms?
(a) One mole of aluminium sulphate
(b) Two moles of ferrous sulphate
(c) Three moles of hydrogen peroxide
(d) Two moles of potassium permanganate
(e) One mole of potassium dichromate

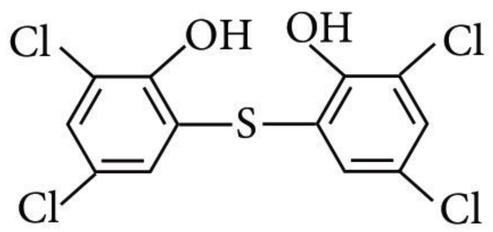
8. Among the following pairs of compounds, the one that does not illustrate the law of multiple proportions, is
(a) NO and NO_2 (b) CuO and Cu_2O
(c) FeO and Fe_2O_3 (d) H_2O and H_2S
(e) NO and N_2O

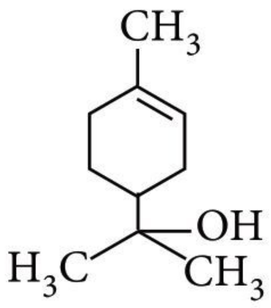
9. A dinegative ion of the element *X* consists of 10 electrons and 8 neutrons. A dipositive ion of the element *Y* consists of 12 protons. The number of neutrons in *Y* is 1.5 times the number of electrons in atom *X*. Then the mass numbers of *X* and *Y* would be in the ratio
(a) 1 : 2 (b) 2 : 3 (c) 3 : 2 (d) 2 : 5
(e) 1 : 3

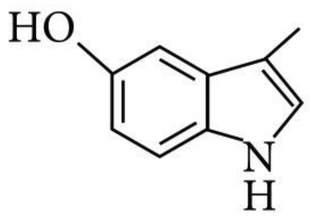
10. A particle of mass 6.6×10^{-31} kg is moving with a velocity of 1×10^{7} ms^{-1}. The de Broglie wavelength (in Å) associated with the particle, is ($h = 6.6 \times 10^{-34}$ J s)
(a) 1 (b) 10 (c) 5 (d) 2
(e) 4

11. From the following, choose the correct structures of chloroxylenol and terpineol, which are the constituents of "Dettol".

(A) 

(B) 

(C) 

(D) 

(a) A and B (b) B and C
(c) A and D (d) A and C
(e) B and D

12. A fast moving particle of mass 6.63×10^{-28} g can be located with an accuracy of 1 Å. The uncertainty in its velocity (in m s^{-1}) is about ($h = 6.63 \times 10^{-34}$ J s)
(a) 8×10^3 (b) 8×10^4
(c) 8×10^5 (d) 8×10^6
(e) 8×10^7

13. Which one of the following molecules contains an incomplete octet of the central atom?
(a) SF_6 (b) $AlCl_3$ (c) CH_4 (d) PF_5
(e) H_2O

14. Which one of the following reactions involves change from sp^2 to sp^3 hybridisation of the central atom?
(a) $CH_4 + 2Cl_2 \rightarrow CH_2Cl_2 + 2HCl$
(b) $NH_3 + H^+ \rightarrow NH_4^+$
(c) $AlCl_3 + Cl^- \rightarrow AlCl_4^-$
(d) $H_2O + H^+ \rightarrow H_3O^+$
(e) $PCl_3 + Cl_2 \rightarrow PCl_5$

15. The dipole-dipole interaction energy between rotating polar molecules is proportional to _____, where 'r' is the distance between polar molecules.
(a) $\frac{1}{r^4}$ (b) $\frac{1}{r^9}$ (c) $\frac{1}{r^3}$ (d) $\frac{1}{r^2}$
(e) $\frac{1}{r^6}$

16. A metal 'X' crystallises in a body centred cubic structure and its metallic radius is 346.4 pm. The length (in pm) of the unit cell is
(a) 200 (b) 800 (c) 600 (d) 500
(e) 400

17. The standard enthalpy of formation of $CH_{4(g)}$, $CO_{2(g)}$ and $H_2O_{(l)}$ are –75 kJ mol^{-1}, –393 kJ mol^{-1} and –286 kJ mol^{-1} respectively. The amount of heat liberated (in kJ) when 3.2 g of methane gas is burnt under standard conditions is
(a) 89 (b) 278 (c) 890 (d) 965
(e) 178

18. Which one of the following is the correct relation between C_p and C_v for one mole of an ideal gas? (R is molar gas constant)
(a) $C_p = C_v - R$ (b) $C_p = C_v + R$
(c) $C_p = R - C_v$ (d) $C_p = C_v \times R$
(e) $C_p = C_v / R$

19. Some of the reactions and their equilibrium constants K_c are given. Choose the reaction which proceeds rarely at the given temperature.
(a) $2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)}$; $K_c = 2.4 \times 10^{47}$ at 500 K
(b) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$; $K_c = 57.0$ at 700 K
(c) $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$; $K_c = 4.0 \times 10^{31}$ at 300 K
(d) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$; $K_c = 4.8 \times 10^{-31}$ at 298 K
(e) $H_{2(g)} + Br_{2(g)} \rightleftharpoons 2HBr_{(g)}$; $K_c = 5.4 \times 10^{18}$ at 300 K

20. The equilibrium constants for the following two reactions at 298 K are given below:
$2A \rightleftharpoons B + C$; $K_1 = 16$
$2B + C \rightleftharpoons 2X$; $K_2 = 25$
What is the value of K for the reaction,
$A + \frac{1}{2}B \rightleftharpoons X$ at 298 K?
(a) $\frac{1}{5}$ (b) $\frac{1}{40}$ (c) $\frac{5}{4}$ (d) $\frac{4}{5}$
(e) 20

21. The average oxidation number of bromine in Br_3O_8 is
(a) $\frac{16}{3}$ (b) $\frac{4}{3}$ (c) $\frac{3}{4}$ (d) $\frac{5}{2}$
(e) $\frac{8}{3}$

22. The standard electrode potentials of some electrodes are given below:

Fe^{3+}/Fe^{2+}	0.77 V;	Br_2/Br^-	1.09 V;
I_2/I^-	0.54 V;	$Zn^{2+}/Zn_{(s)}$	–0.76 V;
$Ag^+/Ag_{(s)}$	0.80 V;	$Fe^{2+}/Fe_{(s)}$	–0.44 V;
$Cu^{2+}/Cu_{(s)}$	0.34 V		

Predict the reaction that is not feasible.
(a) $Fe^{3+}_{(aq)}$ oxidises $I^-_{(aq)}$
(b) $Ag^+_{(aq)}$ oxidises $Cu_{(s)}$
(c) $Ag_{(s)}$ reduces $Fe^{3+}_{(aq)}$

(d) $Br_{2(aq)}$ oxidises $Fe^{2+}_{(aq)}$

(e) $Zn_{(s)}$ reduces $Cu^{2+}_{(aq)}$

23. The chemistry teacher asked the students to prepare 20% *w*/*w* solution of urea [NH_2CONH_2] in water. Which one of the following solution does not conform to the required composition?

(a) 6 g urea dissolved in 24 g water

(b) 20 g urea dissolved in 80 g water

(c) 10 g urea dissolved in 40 g water

(d) 4 g urea dissolved in 16 g water

(e) 15 g urea dissolved in 30 g water

24. The vapour pressures of pure liquids *X* and *Y* at 350 K are 200 mm and 300 mm of Hg respectively. Then the correct vapour pressure (in mm of Hg) of an ideal solution containing *X* and *Y* in the mole ratio 3 : 2 at the same temperature is

(a) 120 (b) 180 (c) 260 (d) 240

(e) 160

25. In a reaction $3A \rightarrow$ Products, the concentration of *A* decreases from 0.4 mol L^{-1} to 0.1 mol L^{-1} in 20 minutes at 300 K. The rate of decrease in [*A*] during this interval (in mol L^{-1} min^{-1}) at 300 K is

(a) 0.005 (b) 0.015 (c) 0.001 (d) 0.15

(e) 0.05

26. The half-life period of a first order reaction at 298 K is 20 minutes. The time (in min.) required for 99.9% completion of the reaction at the same temperature, is

(a) 100 (b) 200 (c) 150 (d) 250

(e) 300

27. The critical temperature of some gases are : methane 190 K, ammonia 405 K, carbon dioxide 304 K, *n*-butane 425 K and dihydrogen 33 K. The gas that is adsorbed to the maximum extent on 1 g of activated charcoal at a given temperature is

(a) dihydrogen (b) methane

(c) carbon dioxide (d) *n*-butane

(e) ammonia.

28. Which one of the following is not true with regard to physisorption?

(a) It arises because of van der Waals' force.

(b) It is not specific in nature.

(c) High activation energy is needed.

(d) It depends on the nature of gas.

(e) Enthalpy of adsorption is low (20-40 kJ mol^{-1}).

29. Match the following:

(A) Saline hydride	(i) CrH
(B) Electron-deficient hydride	(ii) CH_4
(C) Electron-precise hydride	(iii) BeH_2
(D) Electron-rich hydride	(iv) B_2H_6
(E) Metallic hydride	(v) H_2O

Choose the correct option.

(a) (A)-(iii); (B)-(ii); (C)-(iv); (D)-(v); (E)-(i)

(b) (A)-(iii); (B)-(v); (C)-(iv); (D)-(ii); (E)-(i)

(c) (A)-(iv); (B)-(ii); (C)-(iii); (D)-(v); (E)-(i)

(d) (A)-(iii); (B)-(iv); (C)-(ii); (D)-(v); (E)-(i)

(e) (A)-(iii); (B)-(i); (C)-(ii); (D)-(iv); (E)-(v)

30. The metal which dissolves in liquid ammonia to give a blue-black solution due to formation of solvated electron is

(a) aluminium (b) gallium

(c) calcium (d) silicon

(e) germanium.

31. Which one of the following processes does not produce dinitrogen?

(a) Thermal decomposition of ammonium dichromate.

(b) Thermal decomposition of barium azide.

(c) Treating an aqueous solution of ammonium chloride with sodium nitrite.

(d) Thermal decomposition of sodium azide.

(e) Thermal decomposition of ammonium nitrate.

32. Which of the following compounds is used as refrigerant?

(a) CCl_2F_2

(b) $ClCH_2CH_2SCH_2CH_2Cl$

(c) CCl_4

(d) CCl_3NO_2

(e) $COCl_2$

33. Which one of the following set of transition metals have high volatility?

(a) Ti, Zn and Hf (b) Cr, Mo and W

(c) Mn, Tc and Re (d) Fe, Ru and Os

(e) Zn, Cd and Hg

34. Both Cr^{2+} and Mn^{3+} have d^4 configuration. Which one of the following is true?

(a) Mn^{3+} is a reducing agent but Cr^{2+} is an oxidising agent.

(b) Mn^{3+} is an oxidising agent but Cr^{2+} is a reducing agent.

(c) Both Mn^{3+} and Cr^{2+} are oxidising agents.

(d) Both Mn^{3+} and Cr^{2+} are reducing agents.

(e) Both Mn^{3+} and Cr^{2+} are neither reducing nor oxidising agents.

35. The complexes $[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$ are
(a) coordination isomers
(b) geometrical isomers
(c) solvate isomers
(d) ionization isomers
(e) linkage isomers.

36. Which one of the following is not an ore of iron?
(a) Magnesite (b) Haematite
(c) Magnetite (d) Siderite
(e) Iron pyrites

37. The overall complex dissociation equilibrium constant for $[Cr(H_2O)_6]^{3+}$ ion is 5×10^{-12}. The overall stability constant of the complex is
(a) 2×10^{-11} (b) 5×10^{11}
(c) 5×10^{10} (d) 2×10^{11}
(e) 0.2×10^{11}

38. Match the following:

(A) Alkane	(i) Phenol
(B) Alicyclic compound	(ii) Tropolone
(C) Benzenoid aromatic compound	(iii) Isobutane
(D) Non-benzenoid aromatic compound	(iv) Furan
(E) Heterocyclic compound	(v) Cyclohexene

Choose the correct option.
(a) (A)-(iii); (B)-(i); (C)-(v); (D)-(ii); (E)-(iv)
(b) (A)-(iii); (B)-(v); (C)-(i); (D)-(ii); (E)-(iv)
(c) (A)-(i); (B)-(ii); (C)-(iii); (D)-(iv); (E)-(v)
(d) (A)-(iii); (B)-(v); (C)-(i); (D)-(iv); (E)-(ii)
(e) (A)-(iii); (B)-(ii); (C)-(i); (D)-(v); (E)-(iv)

39. The elemental analysis of an organic compound gave C : 38.71%, H : 9.67%. What is the empirical formula of the compound?
(a) CH_2O (b) CH_3O
(c) CH_4O (d) CHO
(e) CH_5O

40. Which one of the following molecules contains only primary and tertiary carbon atoms?
(a) 2, 2-Dimethylbutane
(b) 3-Methylpentane
(c) 2, 3-Dimethylbutane
(d) *n*-Hexane
(e) 2-Methylhexane

41. Calculate the number of σ and π bonds in 2-*n*-propylpent-1-ene.
(a) 22σ bonds, 2π bonds
(b) 23σ bonds, 1π bond
(c) 21σ bonds, 1π bond
(d) 23σ bonds, 2π bonds
(e) 20σ bonds, 1π bond

42. Which one of the following molecules gives four isomeric monochlorides on photochemical chlorination?
(a) 2-Methylpropane (b) *n*-Butane
(c) 2-Methylbutane (d) 2,3-Dimethylbutane
(e) Propane

43. Which of the following aryl chlorides on warming with water forms the corresponding phenol?
(a) 4-Methylchlorobenzene
(b) 4-Nitrochlorobenzene
(c) 2, 4, 6-Trinitrochlorobenzene
(d) 2-Nitrochlorobenzene
(e) 2, 4-Dinitrochlorobenzene

44. Resorcinol is
(a) benzene-1, 3-diol (b) benzene-1, 4-diol
(c) benzene-1, 2-diol (d) 3-methylphenol
(e) 4-methylphenol.

45. Choose the correct order of acidity of the following phenols :
(I) *m*-nitrophenol (II) *p*-cresol
(III) *p*-nitrophenol (IV) phenol
(a) (III) > (I) > (IV) > (II)
(b) (II) > (IV) > (III) > (I)
(c) (I) > (II) > (III) > (IV)
(d) (IV) > (II) > (III) > (I)
(e) (III) > (II) > (I) > (IV)

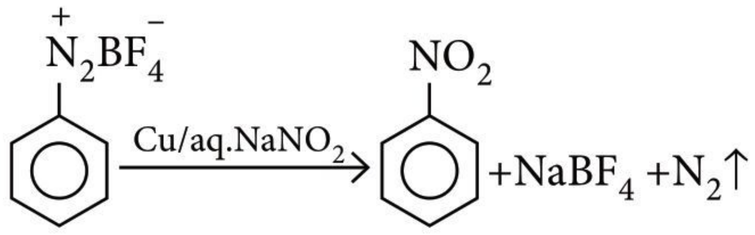
46. Which one of the following represents valeraldehyde?
(a) $CH_3CH_2CH_2CH_2CHO$
(b) $CH_3CH(CH_3)CH_2CHO$
(c) $CH_3CH(OCH_3)CHO$
(d) $(CH_3)_2CHCHO$
(e) $CH_3CH_2CH(CH_3)CHO$

47. Toluene on treatment with chromic oxide in acetic anhydride at 273 K to 283 K gives
(a) benzaldehyde
(b) benzylidene diacetate
(c) benzoic acid
(d) benzyl alcohol
(e) phenylacetate.

48. Among methanamine, ethanamine, benzenamine, *N*-methylaniline and *N*, *N*-dimethylaniline, the weakest and the strongest base in aqueous phase, respectively are
(a) benzenamine and methanamine
(b) *N*-methylaniline and ethanamine
(c) *N*, *N*-dimethylaniline and ethanamine
(d) benzenamine and ethanamine
(e) *N*-methylaniline and methanamine.

SOLUTIONS

1. **(e) :**



2. **(a) :** Glycogen is a polysaccharide of glucose while lactose, maltose and sucrose are disaccharides and glucose is a monosaccharide.

3. **(c)**

4. **(b) :** Neoprene is generally used for making conveyor belts, gaskets and hoses.

5. **(c) :** Morphine, heroin and codeine are narcotic analgesics. Bithional is an antiseptic and is used in soaps to reduce odour due to bacterial decomposition of organic compound on the body. Paracetamol is a non-narcotic analgesic drug.

6. **(a) :** Plants like pinus, juniparus, quercus, pyrus and vitis can metabolise nitrogen oxide which is a primary precursor of photochemical smog.

7. **(a) :** 1 mol of aluminium sulphate $Al_2(SO_4)_3$ has 12 moles of oxygen atoms.
Number of oxygen atoms = $12 \times N_A$
1 mole of ferrous sulphate $FeSO_4$ contains 4 moles of oxygen atoms.
2 moles will have 8 moles of oxygen atoms.
Number of oxygen atoms = $8N_A$
3 moles of H_2O_2 has 6 moles of oxygen atoms.
Number of oxygen atoms = $6N_A$
2 moles of potassium permanganate ($KMnO_4$) has 8 moles of oxygen atoms.
Number of oxygen atoms = $8N_A$
1 mole of potassium dichromate ($K_2Cr_2O_7$) has 7 moles of oxygen atoms.
Number of oxygen atoms = $7N_A$

8. **(d) :** Law of multiple proportion states that if two elements form more than one compound, then the ratios of the masses of the second element which combine with a fixed mass of the first element will always be ratios of small whole numbers.
H_2O and H_2S cannot illustrate this law as they have different elements such as oxygen and sulphur.

9. **(b) :** Given : X^{2-} contains 10 electrons.
Y^{2+} contains 12 protons
Neutrons in $Y = 1.5 \times$ neutrons in X.
X contain 8 electrons, 8 protons and as given it contains 8 neutrons.
Mass number of $X = 8 + 8 = 16$
Neutrons in $Y = 1.5 \times 8 = 12$
Mass number of $Y = 12 + 12 = 24$

$$\frac{\text{Mass number of } X}{\text{Mass number of } Y} = \frac{16}{24} = \frac{2}{3}$$

10. **(a) :** Mass of particle = 6.6×10^{-31} kg
Velocity = 1×10^7 m/s

de Broglie wavelength, $\lambda = \frac{h}{mv}$

$$= \frac{6.6 \times 10^{-34}}{6.6 \times 10^{-31} \times 1 \times 10^{7}} = 1 \times 10^{-10}\ \text{m} = 1\ \text{Å}$$

11. **(d) :** Dettol is mixture of chloroxylenol and terpineol. It contains antispectic properties.

12. **(c) :** $m = 6.63 \times 10^{-28}$ g $= 6.63 \times 10^{-31}$ kg
$\Delta x = 1 \times 10^{-10}\ m$
According to Heisenberg uncertainty principle

$$\Delta p \Delta x = \frac{h}{4\pi}$$

or $$m\Delta v \Delta x = \frac{h}{4\pi}$$

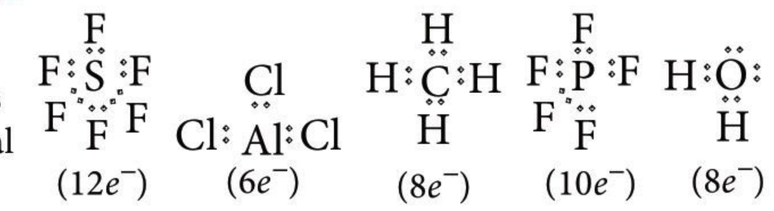
$$\Delta v = \frac{h}{4\pi m \Delta x} = \frac{6.63 \times 10^{-34}}{4 \times 3.14 \times 6.63 \times 10^{-31} \times 1 \times 10^{-10}}$$

$$\Delta v = \frac{10^7}{4 \times 3.14}$$

$$\Delta v = 8 \times 10^5$$

13. **(b):**

Electrons on central atom



($12e^-$) ($6e^-$) ($8e^-$) ($10e^-$) ($8e^-$)

14. **(c) :**

$$\underset{sp^3}{CH_4} + Cl_2 \longrightarrow \underset{sp^3}{CH_2Cl_2} + 2HCl$$

$$\underset{sp^3}{NH_3} + H^+ \longrightarrow \underset{sp^3}{NH_4^+}$$

$$\underset{sp^3}{AlCl_3} + Cl^- \longrightarrow \underset{sp^3}{AlCl_4^-}$$

$$\underset{sp^2}{H_2O} + H^+ \longrightarrow \underset{sp^3}{H_3O^+}$$

$$\underset{sp^3}{PCl_3} + Cl_2 \longrightarrow \underset{sp^3d}{PCl_5}$$

15. (e) : In stationary polar molecules (in solids) dipole dipole interaction energy between the molecules is proportional to $1/r^3$ and between the rotating polar molecules is proportional to $1/r^6$ (r = distance between two polar molecules).

16. (b) : For *bcc* crystal, $r = \frac{\sqrt{3}}{4}a$

$$a = \frac{4r}{\sqrt{3}} = \frac{4 \times 346.4}{1.732}\text{ pm} = 800\text{ pm}$$

17. (e) : Given : $C_{(s)} + 2H_{2(g)} \longrightarrow CH_{4(g)}$;

$\Delta H = -75$ kJ/mol ...(i)

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$; $\Delta H = -393$ kJ/mol ...(ii)

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$; $\Delta H = -286$ kJ/mol ...(iii)

Equations (ii) + 2(iii) – (i) will give our desired equation

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

$\Delta H = -393 + 2 \times (-286) - (-75) = -890$ kJ/mol

1 mol *i.e.* 16 g CH_4 releases 890 kJ of heat.

Then 3.2 g methane will release $= \frac{890}{16} \times 3.2 = 178$ kJ

18. (b) : $C_p - C_v = R$

19. (d) : As the value of K_c is very low, hence it will proceed very slowly or rarely.

20. (e) : $2A \rightleftharpoons B + C$ $K_1 = 16$ ...(i)

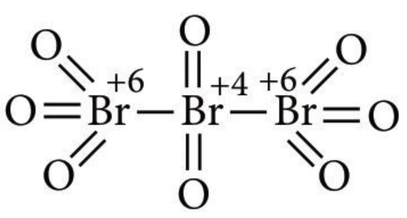
$2B + C \rightleftharpoons 2X$ $K_2 = 25$ ...(ii)

Dividing equations (i) and (ii) by 2 and then adding we get,

$$A + \frac{1}{2}B \rightleftharpoons X$$

$$K = \sqrt{K_1} \times \sqrt{K_2}\ ;\ K = \sqrt{16} \times \sqrt{25} = 4 \times 5 = 20$$

21. (a) :



Average oxidation state = $\frac{16}{3}$

22. (c) : A reaction is feasible if EMF of cell is +ve.

Cathode : At which reduction occurs, Anode : At which oxidation occurs

(a) $2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 0.77 - 0.54$

$= 0.23$V (feasible)

(b) $2Ag^+ + 2Cu \longrightarrow 2Ag + Cu^{2+}$

$E^\circ_{cell} = 0.80 - 0.34 = 0.46$V (feasible)

(c) $2Fe^{3+} + 2Ag \longrightarrow 2Fe^{2+} + 2Ag^+$

$E^\circ_{cell} = 0.77 - 0.80 = -0.03$ (non-feasible)

(d) $Br^- + Fe^{2+} \longrightarrow Br_2 + Fe^{3+}$

$E^\circ_{cell} = 1.09 - 0.77 = 0.32$V (feasible)

(e) $Cu^{2+} + Zn \longrightarrow Cu + Zn^{2+}$

$E^\circ_{cell} = 0.34 - (-0.76) = 1.1$V (feasible)

23. (e) : In (a), 6 g urea in 30 g solution

Mass percentage $\Rightarrow \frac{6}{30} \times 100 = 20\%$

In (b), 20 g urea in 100 g solution $\Rightarrow \frac{20}{100} \times 100 = 20\%$

In (c), 10 g urea in 50 g solution $\Rightarrow \frac{10}{50} \times 100 = 20\%$

In (d), 4g urea dissolved in 20 g solution

$\Rightarrow \frac{4}{20} \times 100 = 20\%$

In (e), 15 g urea dissolved in 45 g solution

$\Rightarrow \frac{15}{45} \times 100 = 33.3\%$

24. (d) : $P^\circ_x = 200$ mm Hg

$P^\circ_y = 300$ mm Hg

$P_s = P^\circ_x \times x_x + P^\circ_y \times x_y$

$$x_x = \frac{3}{5},\ x_y = \frac{2}{5}$$

$$P_s = 200 \times \frac{3}{5} + 300 \times \frac{2}{5} = 120 + 120 = 240\text{ mm Hg}$$

25. (a) : Reaction, $3A \rightarrow$ Products

Initial conc. $(x_1) = 0.4$ mol L^{-1}

Finital conc. $(x_2) = 0.1$ mol L^{-1}

Time interval = 20 min

$$\text{Average rate of reaction} = \frac{-(x_2 - x_1)}{3(t_2 - t_1)} = \frac{0.3}{20 \times 3}$$

$= 0.005$ mol $L^{-1}$$min^{-1}$

26. (b) : $t_{1/2} = 20$ min

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{20}\text{ min}^{-1}$$

For first order reaction,

$$t = \frac{2.303}{k}\log\frac{a}{a-x} = \frac{2.303}{0.693} \times 20 \log\frac{100}{0.1}$$

$$= \frac{2.303}{0.693} \times 20\ \log 10^3$$

$$= \frac{3 \times 20\ \times 2.303}{0.693} = 199.39 \approx 200\text{ min}$$

27. (d) : Extent of adsorption $\propto$ critical temperature
Hence order of adsorption
n-butane > ammonia > CO_2 > CH_4 > H_2

28. (c) : Less heat of adsorption is sufficient for the physisorption to occur. No chemical bonds are formed in physisorption so, there is no necessity of activation energy.

29. (d)

30. (c) : Alkaline earth metals form ammonia solvated cations and electrons when treated with ammonia. The solution formed is electrically conductive, paramagnetic in nature.
The solvated electrons get absorbed in the visible region and thus the solution becomes blue in colour.

31. (e) : $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$

$Ba(N_3)_2 \xrightarrow{\Delta} Ba + 3N_2$

$NH_4Cl + NaNO_2 \xrightarrow{\Delta} NaCl + 2H_2O + N_2$

$2NaN_3 \xrightarrow{\Delta} 2Na + 3N_2$

$NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

32. (a) : CCl_2F_2 (Freon-12), Chloroflorocarbon, is used as refrigerant.

33. (e) : Zn, Cd and Hg have low boiling point due to fully filled *d*-orbitals so they are highly volatile.

34. (b) : $\underset{d^4}{Mn^{3+}} + e^- \longrightarrow \underset{d^5}{Mn^{2+}}$
(half filled, stable)

Hence, Mn^{3+} is good oxidising agent.

$\underset{d^4}{Cr^{2+}} \longrightarrow \underset{d^3}{Cr^{3+}} + e^-$
(t_{2g}^3, stable)

Hence, Cr^{2+} is strong reducing agent.

35. (e) : NO_2 is an ambidentate ligand. It has two different donor atoms linked to central atom in the isomers hence, these are called linkage isomers.

36. (a) : Magnesite : $MgCO_3$
Haematite : Fe_2O_3
Magnetite : Fe_3O_4
Siderite : $FeCO_3$
Iron pyrites : FeS_2

37. (d) : Overall stability constant

$$= \frac{1}{\text{Overall dissociation constant}}$$

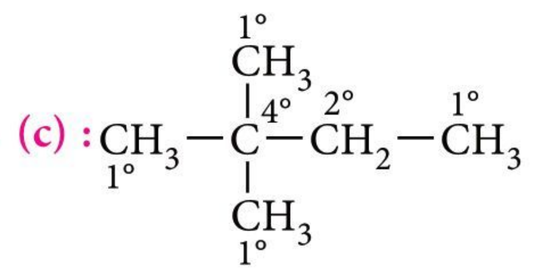
$$= \frac{1}{5\times10^{-12}} = 2\times10^{11}$$

38. (b)

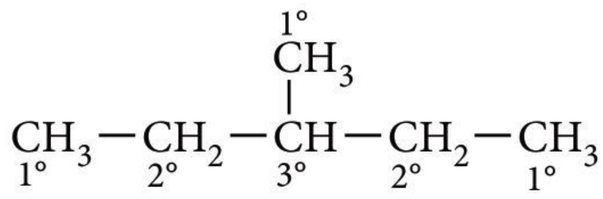
39. (b) :

	C	H	O
Percentage of element	38.71	9.67	100–(38.71+9.67) = 51.62
Number of moles	$\frac{38.71}{12} = 3.22$	$\frac{9.67}{1} = 9.67$	$\frac{51.62}{16} = 3.22$
Simplest ratio	$\frac{3.22}{3.22} = 1$	$\frac{9.67}{3.22} = 3$	$\frac{3.22}{3.22} = 1$
Hence, empirical formula = CH_3O			

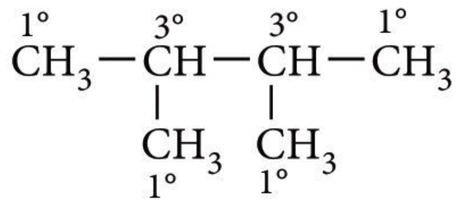
40. (c) :



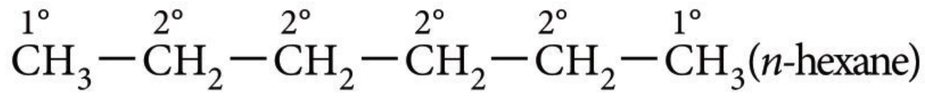
(2, 2-dimethylbutane)



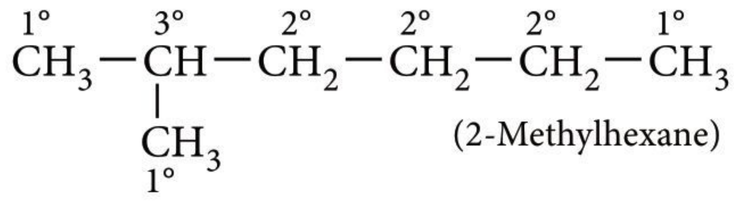
(3-Methylpentane)



(2,3-dimethylbutane)

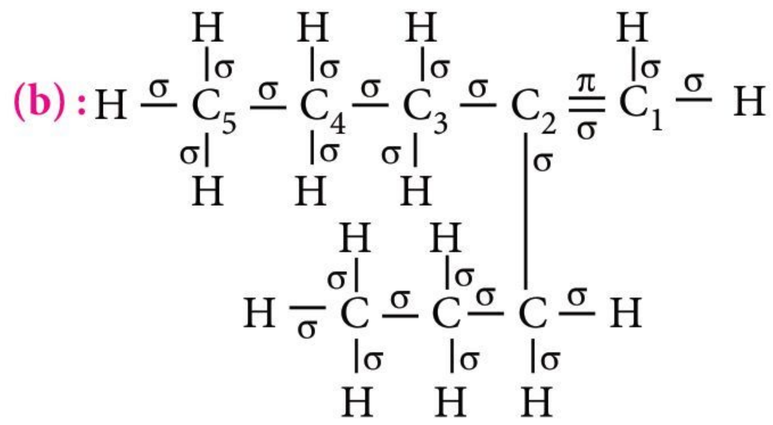


(*n*-hexane)



(2-Methylhexane)

41. (b) :



$C - C \Rightarrow$ 7 σ bonds
$C - H \Rightarrow$ 16 σ bonds
$C = C \Rightarrow$ 1 π bonds
Total 23 σ bonds and one π bond are present.

42. (c) : $\overset{a}{CH_3}-\overset{b}{\underset{\displaystyle \overset{a}{CH_3}}{\underset{|}{CH}}}-\overset{a}{CH_3} \longrightarrow$ 2 isomeric monochlorides

$\overset{a}{CH_3}-\overset{b}{CH_2}-\overset{b}{CH_2}-\overset{a}{CH_3} \longrightarrow$

2 isomeric monochlorides

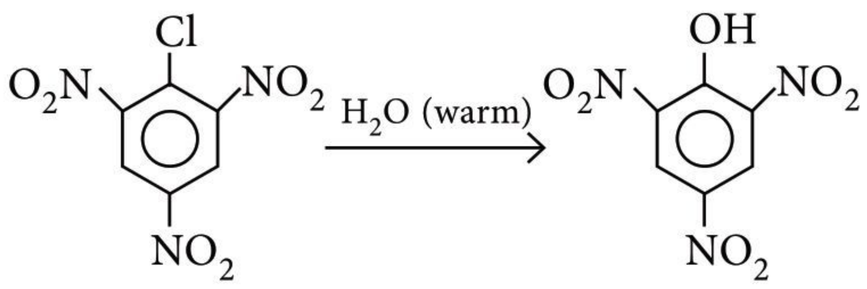
$\overset{a}{CH_3}-\overset{b}{\underset{\displaystyle \overset{a}{CH_3}}{\underset{|}{CH}}}-\overset{c}{CH_2}-\overset{d}{CH_3}$ 4 isomeric monochlorides

$\overset{a}{CH_3}-\overset{b}{\underset{\displaystyle \overset{a}{CH_3}}{\underset{|}{CH}}}-\overset{b}{\underset{\displaystyle \overset{a}{CH_3}}{\underset{|}{CH}}}-\overset{a}{CH_3} \longrightarrow$ 2 isomeric monochlorides

$\overset{a}{CH_3}-\overset{b}{CH_2}-\overset{a}{CH_3} \longrightarrow$ 2 isomeric monochlorides

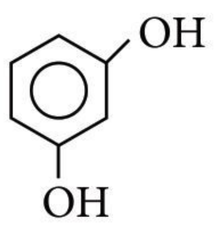
(Considering only structural isomers)

43. (c) : In chlorobenzene, C—Cl bond has partial double bond character due to resonance.
Due to the presence of electron withdrawing group, C—Cl bond weakens hence it becomes easier to undergo nucleophilic substitution reactions.
Due to the presence of three $-NO_2$ groups (having – *M* effect), 2,4,6-trinitrochlrobenzene undergoes nucleophillic substitution easily.



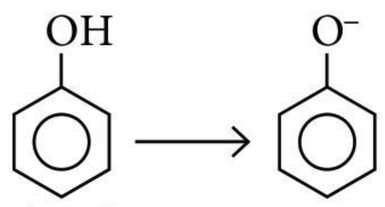
2, 4, 6-Trinitrochlorobenzene — 2, 4, 6–Trinitrophenol

44. (a) :



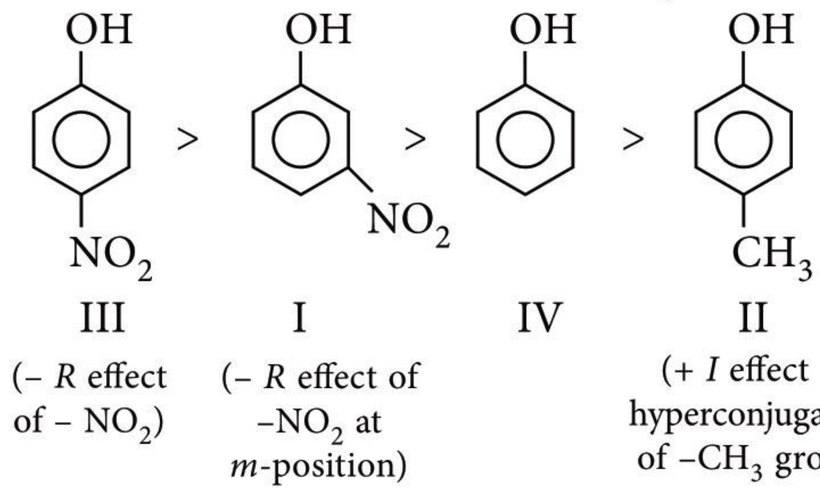
Resorcinol
(Benzene-1,3-diol)

45. (a) : Phenol undergoes dissociation as



Phenol — Phenolate ion

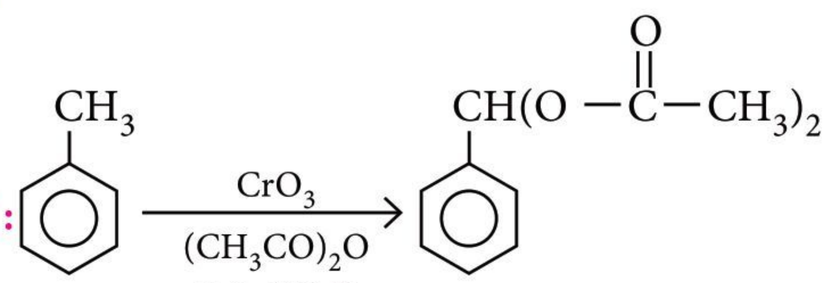
The presence of electron withdrawing group on benzene ring increases the stability of phenolate ions thus, increases the acidity of phenol. While electron donating group decreases stability of phenolate ion as well as the acidity of phenol.
So the correct order of acidic strength is



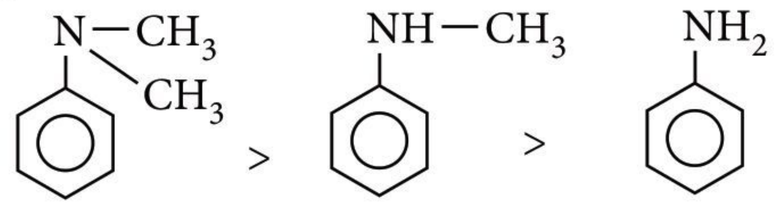
III (– *R* effect of – NO_2) — I (– *R* effect of $-NO_2$ at *m*-position) — IV — II (+ *I* effect or hyperconjugation of $-CH_3$ group)

46. (a)

47. (b) :

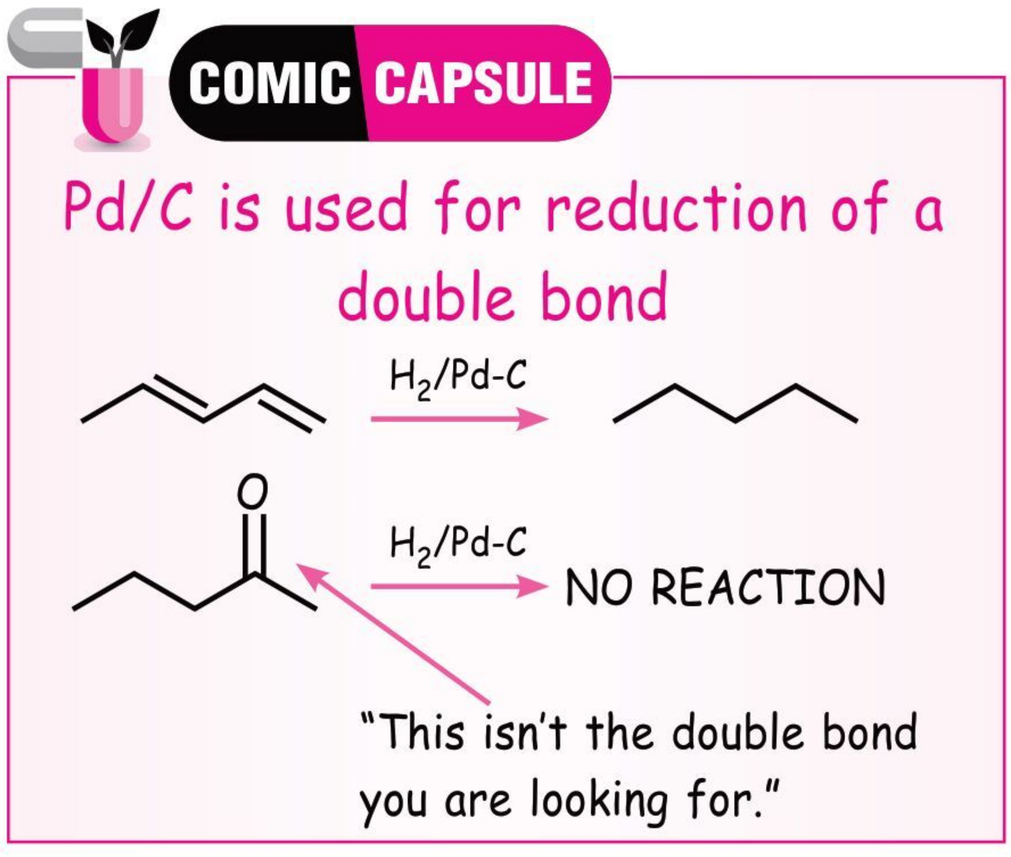


48. (d) : Group having + *I* effect increases basicity of amines while –*I* effect decreases it.
So order of basicity is
$CH_3CH_2NH_2 > CH_3NH_2 >$
(Strongest base)



(Weakest base)

Aromatic amines are weaker bases than aliphatic amines.



CBSE warm-up!

CLASS-XI

Chapterwise practice questions for CBSE Exams as per the latest pattern and reduced syllabus by CBSE for the academic session 2022-23.

Series-1 Some Basic Concepts of Chemistry | Structure of Atom

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

General Instructions : Read the following instructions carefully.

(a) There are 33 questions in this question paper. All questions are compulsory.
(b) Section A : Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
(c) Section B : Q. No. 17 to 25 are short answer questions and carry 2 marks each.
(d) Section C : Q. No. 26 to 30 are short answer questions and carry 3 marks each.
(e) Section D : Q. No. 31 to 33 are long answer questions carrying 5 marks each.
(f) There is no overall choice. However, internal choices have been provided.
(g) Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

Read the passage given below and answer the following questions :

1. Mole was defined with reference to C-12 isotope of carbon chosen as a standard by general conference of weights and measures in 1960 and its mass was taken as 12 atomic mass unit (amu) or 12 unified mass (u).

1 amu = $\frac{1}{12}$ th of the mass of one C-12 atom

$= 1.66 \times 10^{-24}$ g

Mole is defined as the amount of substance that contains as many entities as there are atoms in exactly 12 g (0.012 kg) of C-12 isotope.

Mass of one C-12 atom (determined by mass spectrometer) = 1.992648×10^{-23} g

Mass of one mole of carbon = 12 g

$\therefore$ Number of atoms in 12 g of C-12

$$= \frac{12}{1.992648 \times 10^{-23}} = 6.022137 \times 10^{23} \text{ atoms/mol}$$

The following questions are multiple choice questions. Choose the most appropriate answer.

(i) How many moles of HCl will be present in 100 mL of a solution of specific gravity 1.08 g/cm^3, containing 20% HCl by mass?
(a) 0.50 (b) 0.60 (c) 0.80 (d) 0.12

(ii) How many oxygen atoms will be present in 88 g of CO_2?
(a) 24.08×10^{23} (b) 6.023×10^{23}
(c) 44×10^{23} (d) 22×10^{24}

OR

The number of mole of oxygen in 6.02×10^{24} CO molecules is
(a) 20 (b) 10 (c) 2 (d) 5

(iii) How many molecules of H_2O are present in one drop of water molecules?
(Weight of water drop = 0.00018 g)
(a) 6.022×10^{18} (b) 6.022×10^{22}
(c) 12.044×10^{19} (d) 24.088×10^{23}

(iv) 6.022×10^{20} molecules of ure[a] are present in 100 mL solution. The mole of urea in solution is
(a) 0.1 (b) 0.01 (c) 0.02 (d) 0.001

Read the passage given below and answer the following questions :

2. When an electric discharge is passed through hydrogen gas taken in a discharge tube at low pressure, some radiations are emitted. These radiations on spectroscopic analysis give emission spectrum of hydrogen.
Though a large number of lines appear in the hydrogen spectrum, their wavelengths can be measured by calculating their wave number by

Rydberg Formula *i.e.*, $\bar{\upsilon} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

where R is a constant known as Rydberg constant.

$$R = \frac{2\pi^2 me^4}{ch^3} \approx 109677 \text{ cm}^{-1}$$

or $R = 13.59 \text{ eV} \approx 13.60 \text{ eV}$
$(1 \text{ eV} = 8.0655 \times 10^5 \text{ m}^{-1})$
n_1 and n_2 are the electronic levels involved in transition

In these questions, Q. No. (i)-(iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) **Assertion :** The value of n for a line in Balmer series of hydrogen spectrum having the highest wave length is 4 and 6.
Reason : For Balmer series of hydrogen spectrum, the value of $n_1 = 2$ and $n_2 = 3, 4, 5 \ldots\ldots \infty$.

(ii) **Assertion :** Spectral line would not be seen for a $2p_x - 2p_z$ transition.
Reason : p-orbitals are degenerate orbitals.

(iii) **Assertion :** Electromagnetic radiations will be emitted for the transition of $2p$ to $2s$-orbital in H-atom.
Reason : Both have same energy level and thus, no transition.

OR

Assertion : Brackett series in H-atom is $n_1 = 4$ to $n_2 = 5, 6, 7, 8 \ldots\ldots \infty$.
Reason : The value of Ryderg constant is 109 cm^{-1}.

(iv) **Assertion :** Emitted radiations will fall in visible range when an electron jump from higher level to $n = 2$ in Li^{+2} ion.
Reason : Balmer series radiations belong to visible range in H-atom.

Following questions (Q. No. 3-11) are multiple choice questions carrying 1 mark each :

3. For any Hydrogen (H) like atom, the ratio of velocities of electron is I, II and III orbit *i.e.*, $v_1 : v_2 : v_3$ will be
(a) 1 : 2 : 3 (b) 1 : 1/2 : 1/3
(c) 3 : 2 : 1 (d) 1 : 1 : 1

OR

20 g of $CaCO_3$ on heating gave 8.8 g of CO_2 and 11.2 g of CaO. This is in accordance with
(a) law of conservation of mass
(b) law of definite proportion
(c) law of conservation of energy
(d) Avogadro's law

4. Calculate the molarity of each ion in the solution after 2.0 L of 3 M $AgNO_3$ is mixed with 3 L of 1.0 M $BaCl_2$.
(a) $[Ba^{2+}] = 0.6$ M; $[NO_3^-] = 1.2$ M
(b) $[Ba^{2+}] = [NO_3^-] = 1.2$ M
(c) $[Ba^{2+}] = 1.0$ M ; $[NO_3^-] = 3.0$ M
(d) None of these

5. If the value of $n + l = 7$, then what should be the increasing order of energy of the possible sub-shells?
(a) $4f < 5d < 6p < 7s$ (b) $7s < 6p < 5d < 4f$
(c) $7s < 6p < 5d < 4p$ (d) $4f < 5d < 7s < 6p$

6. How many atoms are contained in one mole of sucrose ($C_{12}H_{22}O_{11}$)?
(a) $20 \times 6.02 \times 10^{23}$ atoms/mol
(b) $45 \times 6.02 \times 10^{23}$ atoms/mol
(c) $5 \times 6.02 \times 10^{23}$ atoms/mol
(d) None of these

OR

How many molecules are present of a gas occupies a volume of 22.4 L (at STP)?
(a) $0.6\ N_A$ (b) $0.5\ N_A$ (c) N_A (d) $2\ N_A$

7. 10 g $CaCO_3$ on heating leaves behind a residue weighing 5.6 g. Carbon dioxide released into the atmosphere at STP will be
(a) 2.24 L (b) 4.48 L (c) 1.12 L (d) 0.56 L.

8. Consider the ground state of Cr atom ($Z = 24$). The number of electrons with the azimuthal quantum numbers $l = 1$ and 2 are respectively
(a) 12 and 4 (b) 12 and 5
(c) 16 and 4 (d) 16 and 5

9. In the reaction
$4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(l)}$
when 1 mol of ammonia and 1 mol of O_2 are made to react to completion
(a) 1.0 mole of H_2O is produced
(b) 1.0 mole of NO will be produced
(c) all the ammonia will be consumed
(d) all the oxygen will be consumed.

OR

The number of molecules in 16 g of methane is
(a) 3.0×10^{23} (b) 6.02×10^{23}
(c) $\frac{16}{6.02} \times 10^{23}$ (d) $\frac{16}{3.0} \times 10^{23}$

10. The increasing order (lowest first) from the values of e/m (charge/mass) for electron (e), proton (p), neutron (n) and alpha particle (α) is
(a) e, p, n, α (b) n, p, e, α
(c) n, p, α, e (d) n, α, p, e

OR

A compound contains atoms of three elements as A, B and C. If the oxidation number of A is +2, B is +5 and that of C is –2, the possible formula of the compound is
(a) $A_3(B_4C)_2$ (b) $A_3(BC_4)_2$
(c) ABC_2 (d) $A_2(BC_3)_2$

11. Total number of electrons, protons and neutrons present in the nucleus of $^{238}_{92}U$ is
(a) $e = 92, p = 92, n = 146$
(b) $e = 92, p = 92, n = 148$
(c) $e = 0, p = 92, n = 146$
(d) None of these.

In the following questions (Q. No. 12 - 16) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

12. **Assertion :** Energy emitted when an electron an electron jump from $5 \rightarrow 2$ (energy level) is less than when an electron jump from $2 \rightarrow 1$ in all hydrogen like atoms.
Reason : The energy of electron in atom is quantzed.

13. **Assertion :** Atomic mass and molecular mass are unit less.
Reason : Molar mass is equal to the mass of 6.023×10^{23} atoms.

OR

Assertion : 1.231 has three significant figures.
Reason : All non zero numbers are significant.

14. **Assertion :** Thomson's analysis of cathode ray experiments led him to conclude that electrons were fundamental particles.
Reason : e/m ratio for particles in cathode rays was found to be independent of the nature of the gas taken in the tube.

15. **Assertion :** The angular momentum of an electron in n^{th} orbit is same for all hydrogen-like species.
Reason : The velocity of electron in n^{th} orbit is equal for all H-like species.

16. **Assertion :** The spectrum of He^+ is expected to be similar to that of hydrogen.
Reason : He^+ is also one electron system.

SECTION - B

The following questions, (Q. No. 17-25) are short answer type and carry 2 marks each.

17. Atomic radius is of the order of 10^{-8} cm and nucleus radius is of the order of 10^{-13} cm. Calculate what fraction of atom is occupied by nucleus?

OR

From the following list of atoms, choose the isotopes, isobars and isotones.
$^{16}_{8}O$, $^{39}_{19}K$, $^{235}_{92}U$, $^{40}_{19}K$, $^{14}_{7}N$, $^{18}_{8}O$, $^{14}_{6}C$, $^{40}_{20}Ca$, $^{238}_{92}U$

18. $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$
Calculate the eq. wt. of Zn and $FeSO_4$.

19. **(a)** For any multielectron species, compare and justify the energies of following orbitals.
$3d_{xy}$, $2s$, $4p_x$, $4p_y$
(b) Compare the "average distance" of the following orbitals from the nucleus. Also comment on their 'chances of closeness to the nucleus" if they have same average distance"
Orbitals to be compared : $1s$, $2s$, $3s$, $3p_x$, $3d_{xy}$

OR

The electron energy in hydrogen atom is given $E_n = \frac{-21.8 \times 10^{-18}}{n^2}$. Calculate the energy required to remove an e^- completely fron $n = 2$ orbit. What is the largest wavelength in cm of light that can be used to cause this transition.

20. Calculate the volume of chlorine that can be obtained at STP reaction of 1.58 g of $KMnO_4$ and excess of hydrochloric acid.

OR

The vapour density of a mixture containing NO_2 and N_2O_4 is 38.3 at 27°C. Calculate the mole of NO_2 in 100 mol mixture.

21. **(i)** What is the energy and wavelength of photons of frequency 3.4 MHz.

(ii) Also calculate the energy per mole of photons of the same wavelength.

22. Calculate the weight of iron which will be converted into its oxide by the action of 18 g of steam.

23. What % decrease will appear in the mass number if the number of neutrons is halved and number of electrons is doubled in $^{16}_{8}O$?

24. Two substances *X* and *Y* combine to give a substance *Z*. The process is exothermic and *Z* has properties different from those of *X* and *Y*. Is the substance *Z* an element, a mixture or a compound?
Give explanation to support your answer.

25. Which of the following will not show deflection from the path on passing through an electric field?
Proton, cathode rays, electron, neutron.

SECTION - C

Q. No. 26-30 are short answer type II carrying 3 marks each.

26. **(a)** The number of electrons, protons and neutrons in a species are equal to 18, 16 and 16 respectively. Assign the proper symbol to the species.

(b) How many nucleons are present in an atom of Nobelium, $^{254}_{102}No$? How many of these may be considered as neutrons?

OR

(i) What is black body radiation?

(ii) The work function for caesium atom is 1.9 eV. Calculate the threshold wavelength.
(Given : 1 eV = 1.6×10^{-19} J)

27. 5.325 g sample of methyl benzoate, a compound used in the manufacture of perfumes is found to contains 3.758 g of carbon, 0.316 g hydrogen and 1.251 g of oxygen. What is empirical formula of compound ? If molecular weight of methyl benzoate is 136.0, calculate its molecular formula.

OR

Convert the following :

(i) 200 lb into kilogram

(ii) 0.800 carat into grams and kilograms
(1 carat = 3.168 grains and 1 g = 15.4 grains)

(iii) 8.0 km into inches (1 m = 1.094 yd and 1 yd = 36 inch)

28. **(i)** What do you mean by 'significant figures'?

(ii) Express the result of the following data to the appropriate number of significant figures :

$$\frac{4.84 \times 0.0744}{6.016}$$

29. **(a)** What is an orbital?

(b) An electron is in one of the 3*d* orbitals. Give the possible values of *n*, *l* and m_l for this electron.

30. Calculate the uncertainty in position of an electron if uncertainty in its velocity is 0.001%. Mass of electron = 9.1×10^{-31} kg, velocity of electron = 300 m s^{-1}.
($h = 6.626 \times 10^{-34}$ kg m^2 s^{-1})

SECTION - D

Q. No. 31-33 are long answer type carrying 5 marks each.

31. **(a)** Calculate the number of moles in each of the following :

(i) 11 g of CO_2

(ii) 3.01×10^{22} molecules of CO_2

(b) Calculate number of molecules in each of the following :

(i) 14 g of nitrogen (ii) 3.4 g of H_2S

OR

Three oxides of lead on analysis were found to contain lead as under :

(i) 3.45 g of yellow oxide contains 3.21 g of lead.

(ii) 1.195 g of brown oxide contains 1.035 g of lead.

(iii) 1.77 g of red oxide contains 1.61 g of lead.
Show that these data illustrate law of multiple proportions.

32. (a) State photoelectric effect. What is meant by work function of the metal?

(b) The threshold frequency for a metal '*X*' is $7.0 \times 10^{14}\ s^{-1}$. Calculate the kinetic energy of an electron emitted when radiation of frequency $1.0 \times 10^{15}\ s^{-1}$ strikes the metal.

OR

(i) Discuss the possibility of the atom for existing in the following electronic configuration :

(a) $1s^2\ 2s^2\ 2p_x^1$ (b) $1s^2\ 2s^1 2p_x^1\ 2p_y^1\ 2p_z^1$

(c) $1s^2\ 2s^2\ 2p_x^2\ 2p_y^1$ (d) $1s^2\ 2s^2\ 3s^2$

(ii) Why Bohr's orbits are called stationary orbits or states?

33. (i) When a mixture of $MgCO_3$ and $CaCO_3$ was heated for a long time, the weight was decreased by 50%. Calculate the percentage composition of the mixture.

(ii) A mixture of N_2 and H_2 is made to react in a closed container to form NH_3. The reaction ceases before either reactant has been totally consumed. At this stage, 2.0 mol each of N_2, H_2 and NH_3 are present. Calculate the number of mol of N_2 and H_2 present originally.

OR

(i) Consider the reaction :

$2A_{(g)} + 4B_{(g)} \rightarrow 3C_{(g)} + 4D_{(g)}$

when 5 moles of *A* and 6 moles of *B* are mixed together.

(a) Which one is the limiting reagent?

(b) Calculate the amount (no. of moles) of '*C*' formed.

(ii) Calculate the molarity (*M*) and molality (*m*) of 16% aqueous methanol (CH_3OH) solution by volume.

(Given : Density of solution = 0.9 g mL^{-1}).

SOLUTIONS

1. (i) (b) : Mass of solution = $100 \times 1.08 = 108$ g

$$\text{Mass of HCl present in solution} = \frac{108 \times 20}{100} = \frac{108}{5}\ \text{g}$$

$$\text{Number of moles} = \frac{108}{5} \times \frac{1}{36.5} = 0.59 \approx 0.60$$

(Molecular weight of HCl = 36.5 g/mol)

(ii) (a) : Mole of $CO_2 = \frac{88}{44} = 2$ mole

molecule of CO_2 contains, two oxygen atoms

2 mole of CO_2 contain, oxygen atom

$= 2 \times 2 \times 6.022 \times 10^{23} = 24.088 \times 10^{23}$

OR

(b) : 6.02×10^{24} CO molecules $= \frac{6.02 \times 10^{24}}{6.02 \times 10^{23}} = 10$ mol

(iii) (a) : Weight of water drop = 0.00018 g

Molecular mass of water = 18 g/mol

$$\text{Mole of water} = \frac{0.00018}{18} = 0.00001 = 10^{-5}$$

Number of molecules of water in 0.00018 g is

$= 6.022 \times 10^{23} \times 10^{-5} = 6.022 \times 10^{18}$

(iv) (d) : mole of urea $= \frac{6.022 \times 10^{20}}{6.022 \times 10^{23}} = 10^{-3} = 0.001$

2. (i) (d) **(ii) (a)**

(iii) (d) **OR** **(c)** **(iv) (a)**

3. (b) : orbit $(n_1) = 1$, $v_1 = \frac{v_0}{1}$

orbit $(n_2) = 2$, $v_2 = \frac{v_0}{2}$; orbit $(n_3) = 3$, $v_3 = \frac{v_0}{3}$

$v_1 : v_2 : v_3 \quad \therefore \frac{v_0}{1} : \frac{v_0}{2} : \frac{v_0}{3} \quad \therefore \frac{1}{1} : \frac{1}{2} : \frac{1}{3}$

OR

(a) : Matter can neither be created nor be destroyed.

4. (a) : $2AgNO_3 + BaCl_2 \longrightarrow 2AgCl_{(s)} + Ba(NO_3)_{2(aq)}$

$$[Ba^{2+}] = \frac{1.0 \times 3}{2+3} = 0.6\ \text{M}$$

$$[NO_3^-] = \frac{2 \times 1 \times 3}{2+3} = 1.2\ \text{M}$$

5. (a) : For all the given orbitals, $n + l = 7$

$7 + 0 = 7s$

$6 + 1 = 6p$

$5 + 2 = 5d$

$4 + 3 = 4f$

If $(n + l)$ value is same of different type of orbital, the orbital with lower value of *n* has lower energy

Order of energy, $4f < 5d < 6p < 7s$

6. (b) : Total atoms in 1 molecule of $C_{12}H_{22}O_{11}$

$= 12 + 22 + 11 = 45$

$\therefore$ Total atoms in 1 mole of $C_{12}H_{22}O_{11}$

$= 45 \times 6.02 \times 10^{23}$ atoms/mol.

OR

(c) : 1 mole of gas at STP = 22.4 L.

7. **(a)** **8.** **(b)**

9. **(d)** **OR** **(b)**

10. **(d) :** e/m for $n = 0/1 = 0$;

for α-particle $= 2/4 = 0.5$;

for proton $= 1/1 = 1$

and for electron, $e/m = \dfrac{1}{1/1837} = 1837$

OR

(b) : Sum of oxidation states must be equal to zero which is given by $A_3(BC_4)_2 = A_3B_2C_8$ $(+6 + 10 - 16 = 0)$

11. **(c) :** There is no electron in the nucleus.

$n_e = 0$, $n_p = 92$, $n_n = 238 - 92 = 146$

12. **(b)** **13.** **(b)** **OR** **(d)**

14. **(a) :** e/m ratio for particles in cathode rays comes out to be same for all gases.

$e/m = 1.76 \times 10^{11}$ C/kg.

This led to the conclusion that electrons were fundamental particles.

15. **(c)**

16. **(a) :** All species like He^+, Li^{2+}, Be^{3+} having one electron are expected to have similar spectrum as that of hydrogen.

17. Volume of nucleus $= \dfrac{4}{3}\pi r^3 = \dfrac{4}{3}\pi(10^{-13})^3$ cm^3

Volume of atom $= \dfrac{4}{3}\pi(10^{-8})^3$ cm^3

$$\frac{V_{\text{Nucleus}}}{V_{\text{Atom}}} = \frac{10^{-39}}{10^{-24}} = 10^{-15}$$

OR

Isotopes : $\left({}^{16}_{8}\text{O}, {}^{18}_{8}\text{O}\right), \left({}^{39}_{19}\text{K}, {}^{40}_{19}\text{K}\right), \left({}^{235}_{92}\text{U}, {}^{238}_{92}\text{U}\right)$

Isobars : $\left({}^{40}_{19}\text{K}, {}^{40}_{20}\text{Ca}\right), \left({}^{14}_{7}\text{N}, {}^{14}_{6}\text{C}\right)$

Isotones : $\left({}^{39}_{19}\text{K}, {}^{40}_{20}\text{Ca}\right), \left({}^{14}_{6}\text{C}, {}^{16}_{8}\text{O}\right)$

18. $Zn \longrightarrow ZnSO_4$

$Zn \longrightarrow Zn^{2+}$ (oxidation)

$$\text{Eq. wt of Zn} = \frac{\text{Atomic weight of Zn}}{\text{No. of } e^- \text{ lost by Zn}} = \frac{65}{2} = 32.5$$

$FeSO_4 \longrightarrow Fe$

$Fe^{2+} \longrightarrow Fe$

$$\text{Eq. wt. } FeSO_4 = \frac{\text{Molecular weight of } FeSO_4}{\text{Number of } e^- \text{ gained by } FeSO_4}$$

$$= \frac{152}{2} = 76$$

19. **(a)** $2s < 3d_{xy} < 4p_x = 4p_y$

Orbital with higher value of $(n + l)$ have high energy $(n + l)$same.

Then, higher value of n, higher will be the energy

(b) Average distance (on the basis of n) :

$1s < 2s < 3s = 3p_x = 3d_{xy}$

Closeness comparison: $3s$ will be more close as compared to $3p_x$ as compared to $3d_{xy}$.

OR

For complete removal from $n = 2$

$$\Delta E_n = +2.18 \times 10^{-18}\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]$$

$$= 5.45 \times 10^{-17} \text{ J}$$

$$\frac{hc}{\lambda} = \Delta E_n \Rightarrow \lambda = \frac{hc}{\Delta E_n} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{5.45 \times 10^{-17}}$$

$$= 3.6 \times 10^{-9} \text{ cm}$$

20. $\underset{\substack{2 \text{ mole} \\ (316 \text{ g})}}{2KMnO_4} + 16HCl \rightleftharpoons 2KCl + 2MnCl_2 + 8H_2O + \underset{\substack{5 \text{ mole} \\ (5 \times 22.4 \text{ at STP})}}{5Cl_2}$

Thus, volume of Cl_2 produced at STP

$$= \frac{5 \times 22.4 \times 1.58}{316} = 0.560 \text{ L or } 560 \text{ mL}$$

OR

Molecular wt. of mixture of NO_2 and $N_2O_4 = 38.3 \times 2$

$= 76.6$ g

Let x moles of NO_2 are present in 100 mol mixture

$\therefore$ Moles of $N_2O_4 = (100 - x)$

wt. of NO_2 + wt. of N_2O_4 = total wt. of mixture

$(x \times 46) + (100 - x) \times 92 = 100 \times 76.6$ g

$x = 33.48$ moles

21. (i) $\nu = 3.4$ MHz $= 3.4 \times 10^6$ Hz $= 3.4 \times 10^6$ s^{-1}

$$\lambda = \frac{c}{\nu} = \frac{3 \times 10^8 \text{ m s}^{-1}}{3.4 \times 10^6 \text{ s}^{-1}} = 88.2 \text{ m}$$

Energy, $E = h\nu = 6.626 \times 10^{-34} \times 3.4 \times 10^{6}$ J
$= 2.253 \times 10^{-27}$ J

(ii) Energy per mole of photon
$= 6.02 \times 10^{23} \times 2.253 \times 10^{-27}$ J mol^{-1}
$= 1.356 \times 10^{-3}$ J mol^{-1}

22. The required equation is

$$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$$
$$3 \times 56 \text{ g} \quad 4 \times 18 \text{ g}$$
$$\frac{3 \times 56}{4} g \quad 18 \text{ g}$$

$\therefore$ Weight of Fe converted into oxide by 18 g of steam = 42 g.

23. $^{16}_{8}O$

Protons	$8p$	$\rightarrow$	$8p$
Neutrons	$8n$	$\rightarrow$	$4n$
Mass number	16	$\rightarrow$	12

Change in mass number =
Initial mass number – Final mass number = 4

Thus, decrease in mass number $= \frac{4}{16} \times 100 = 25\%$

24. The substance Z is a compound. This is because
(i) heat is evolved during the formation of Z.
(ii) the properties of Z are different from those of X and Y.

25. Neutron is a neutral particle. Hence, it will not be deflected on passing through an electric field.

26. (a) The atomic number is equal to number of protons = 16. Thus, the element is sulphur (S).
Mass number = number of protons
+ number of neutrons = 16 + 16 = 32
Species is not neutral as the number of protons is not equal to electrons. It is anion (negatively charged) with charge equal to excess electrons = 18 – 16 = 2
Thus, the symbol is $^{32}_{16}S^{2-}$.

(b) Nucleons = 254
Nucleons = neutrons + protons = 254
Neutrons = nucleons – protons = 254 – 102 = 152

OR

(i) If the substance being heated is a black body (which is a perfect absorber and perfect radiator of energy, *i.e.*, which can emit and absorb all frequencies), the radiation emitted is called black body radiation.

(ii) Work function = $h\upsilon_0$ = 1.9 eV
$= 1.9 \times 1.6 \times 10^{-19}$ J $= 3.04 \times 10^{-19}$ J

Threshold frequency,

$$\upsilon_0 = \frac{3.04 \times 10^{-19}}{6.626 \times 10^{-34}} = 4.59 \times 10^{14} \text{ sec}^{-1}$$

Threshold wavelength,

$$\lambda_0 = \frac{c}{\upsilon_0} = \frac{3 \times 10^{8}}{4.59 \times 10^{14}} = 6.54 \times 10^{-7} \text{ m}$$

or 654×10^{-9} cm or 654 nm

27.

Element	%	Molar ratio	Simplest Whole No. ratio
C	$\frac{3.758 \times 100}{5.325} = 70.57$	$\frac{70.57}{12} = 5.88$	$\frac{5.88}{1.47} = 4$
H	$\frac{0.316 \times 100}{5.325} = 5.93$	$\frac{5.93}{1.00} = 5.93$	$\frac{5.93}{1.47} = 4$
O	$\frac{1.251 \times 100}{5.325} = 23.50$	$\frac{23.50}{16} = 1.47$	$\frac{1.47}{1.47} = 1$

$\therefore$ Empirical formula = C_4H_4O

$$n = \frac{\text{Mol. wt}}{\text{Empirical formula wt.}} = \frac{136}{68} = 2$$

$\Rightarrow$ Molecular formula = $2 \times (C_4H_4O) = C_8H_8O_2$

OR

(i) 1 kg = 2.205 lb

$\therefore$ $\frac{2.205 \text{ lb}}{1 \text{ kg}} = 1 = \frac{1 \text{ kg}}{2.205 \text{ lb}}$

Hence, 200 lb = 200 lb $\times \frac{1 \text{ kg}}{2.205 \text{ lb}}$ = 90.7 kg

(ii) 1 carat = 3.168 grains

$$\frac{1 \text{ carat}}{3.168 \text{ grains}} = 1 = \frac{3.168 \text{ grains}}{1 \text{ carat}}$$

1 g = 15.4 grains

$$\frac{1 \text{ g}}{15.4 \text{ grains}} = 1 = \frac{15.4 \text{ grains}}{1 \text{ g}}$$

$$0.800 \text{ carat} = 0.800 \text{ carat} \times \frac{3.168 \text{ grains}}{1 \text{ carat}} \times \frac{1 \text{ g}}{15.4 \text{ grains}}$$

$$= \frac{0.800 \times 3.168 \times 1}{15.4} = 0.16 \text{ g}$$

$$0.16 \text{ g} = 0.16 \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 0.00016 \text{ kg}$$

(iii) 1 km = 1000 m

$$\frac{1000 \text{ m}}{1 \text{ km}} = 1 = \frac{1 \text{ km}}{1000 \text{ m}} \text{ ; } 1 \text{ m} = 1.094 \text{ yd}$$

$$\frac{1.094 \text{ yd}}{1 \text{ m}} = 1 = \frac{1 \text{ m}}{1.094 \text{ yd}} \text{ ; } 1 \text{ yd} = 36 \text{ inch}$$

$$\frac{36 \text{ inch}}{1 \text{ yd}} = 1 = \frac{1 \text{ yd}}{36 \text{ inch}}$$

$$8.0 \text{ km} = 8.0 \text{ km} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1.094 \text{ yd}}{1 \text{ m}} \times \frac{36 \text{ inch}}{1 \text{ yd}}$$

$$= 315072 = 3.1 \times 10^5 \text{ inches}$$

The result is to be reported upto 2 significant figures since the least precise term (8.0) has 2 significant figures.

28. (i) The total number of digits in a number including the last digit whose value is uncertain is called significant figures. For example, in the value 14.5678 g, there are six significant figures.

(ii) $\frac{4.84 \times 0.0744}{6.016} = 0.059856$

As 4.84 or 0.0744 has least number of three significant figures, the result should contain three significant figures only. Hence, the result after rounding off is 0.0598.

29. (a) Orbital is a three-dimensional region of different shapes which does not have definite path and there is maximum probability of finding out the electron in that region.

(b) For 3*d*-orbital, $n = 3$, $l = 2$, $m_l = -2, -1, 0, +1, +2$.

30. $\Delta x \times m\Delta v = \frac{h}{4\pi}$; $\Delta x = \frac{h}{4\pi\, m\Delta v}$

Given : Velocity of electron = 300 m s^{-1}, $\Delta V = 0.001\%$, $m = 9.1 \times 10^{-31}$ kg, $h = 6.626 \times 10^{-34}$ J s

$$\Delta x = \frac{6.626 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-2}}{4 \times 3.14 \times 9.1 \times 10^{-31} \text{kg} \times \left(\frac{0.001}{100} \times 300\right) \text{m s}^{-1}}$$

$$= 1.932 \times 10^{-2} \text{ m}$$

31. (a) (i) 44 g of CO_2 = 1 mol

$$11 \text{ g of } CO_2 = \frac{1}{44} \times 11 = \frac{1}{4} = 0.25 \text{ mol}$$

(ii) 6.023×10^{23} molecules = 1 mol

$$3.01 \times 10^{22} \text{ molecules} = \frac{1 \times 3.01 \times 10^{22}}{6.023 \times 10^{23}} = 0.05 \text{ mol}$$

(b) (i) 28 g of $N_2 = 6.023 \times 10^{23}$ molecules

$$14 \text{ g of } N_2 = \frac{6.023 \times 10^{23}}{28} \times 14 = 3.01 \times 10^{23} \text{ molecules}$$

(ii) 3.4 g of $H_2S = \frac{6.023 \times 10^{23}}{34} \times 3.4$

$$= 6.023 \times 10^{22} \text{ molecules}$$

OR

The amounts of lead and oxygen in three oxides are :

(i) Yellow oxide : Mass of lead = 3.21 g
Mass of oxygen = 3.45 – 3.21 = 0.24 g

(ii) Brown oxide : Mass of lead = 1.035 g
Mass of oxygen = 1.195 – 1.035 = 0.16 g

(iii) Red oxide : Mass of lead = 1.61 g
Mass of oxygen = 1.77 – 1.61 = 0.16 g

Let us fix the mass of lead as 1 g and calculate the different weights of oxygen which combine with 1 g of lead in these oxides.

(i) Yellow oxide :

Mass of oxygen which combines with 3.21 g of lead = 0.24 g

Mass of oxygen which combines with 1 g of lead

$$= \frac{0.24}{3.21} = 0.075 \text{ g}$$

(ii) Brown oxide :

Mass of oxygen which combines with 1.035 g of lead = 0.16 g

Mass of oxygen which combines with 1 g of lead

$$= \frac{0.16}{1.035} = 0.15 \text{ g}$$

(iii) Red oxide :

Mass of oxygen which combines with 1.61 g of lead = 0.16 g

Mass of oxygen which combines with 1 g of lead

$$= \frac{0.16}{1.61} = 0.10 \text{ g}$$

The ratio of different masses of oxygen which combine with same mass of lead (1 g) in these oxides is :

$$0.075 : 0.15 : 0.10$$
$$3 : 6 : 4$$

This is a simple whole number ratio.

Hence, the data illustrate the law of multiple proportions.

18+

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32. (a) When a beam of light of certain frequency strikes the surface of some metals, electrons are emitted or ejected from the metal surface. This phenomenon is called photoelectric effect.

Work function (w_0) is the minimum energy required for the emission of a photoelectron having kinetic energy zero.

Work function is same as ionisation energy for an element, thus putting $w = I.E.$ of atom, we get

$h\nu$ = I. E. + K. E.

(b) $\upsilon = 1.0 \times 10^{15}\ s^{-1}$, $K.E. = 1.988 \times 10^{-19}$ J, $\upsilon_0 = ?$

$h\upsilon = h\upsilon_0 + K.E.$

$6.626 \times 10^{-34} \times 1.0 \times 10^{15} = 6.626 \times 10^{-34} \times \upsilon_0 + 1.988 \times 10^{-19}$

$\upsilon_0 = 7.0 \times 10^{14}\ s^{-1}$

Electron will be emitted only if the specified threshold frequency and accordingly wavelength is given to it.

When, $\lambda = 600\ nm = 6 \times 10^{-7}$ m

$$\upsilon = \frac{c}{\lambda} = \frac{3\times10^{8}}{6\times10^{-7}} = 5\times10^{14}\ s^{-1}$$

Hence, $\upsilon < \upsilon_0$, no electron will be emitted.

OR

(i) (a) This electronic configuration is correct since it is in accordance with the rules for filling up various orbitals.

(b) This electronic configuration is wrong because it violates Aufbau principle.

(c) This electronic configuration is not correct since it violates Hund's rule.

(d) This electronic configuration is wrong since after filling 2*s*-orbital, the electrons should go to 2*p*-orbital rather than 3*s*-orbital. Thus, the correct electronic configuration will be $1s^2\ 2s^2\ 2p^2$.

(ii) It is because electrons do not radiate energy as long as they remain in the same energy level.

33. (i) $MgCO_3 + CaCO_3 \longrightarrow MgO + CaO + 2CO_2$

84 g 100 g 40 g 56 g

x = number of mole of $MgCO_3$

y = number of mole of $CaCO_3$

Total initial weight of solid phase = $(84x + 100y)$ g

If $[Mg\ CO_3] = [MgO]$

$[\ CaCO_3] = [CaO]$

Final weight of solid phase = $(40x + 56y)$ g

Final weight = 50% of initial weight

So, 50 % of $(84x + 100y) = 40x + 56y$

$42x + 50y = 40x + 56y$

$2x = 6y$

$$\frac{x}{y} = \frac{6}{2} = \frac{3}{1} \qquad x : y = 3:1$$

if 3 moles of $MgCO_3 = 3 \times 84 = 252$ g

1 mole of $CaCO_3 = 1 \times 100 = 100$ g

Total mass of mixture = 352 g

$$\text{percentage of } MgCO_3 = \frac{252}{352} \times 100 = 71.6\%$$

$$\text{Percentage of } CaCO_3 = \frac{100}{352} \times 100 = 28.4\%$$

(ii) $N_2 + 3H_2 \rightarrow 2NH_3$

It is clear from the balanced chemical equation that formation of 2 mol of NH_3 must consume 1 mol of N_2 and 3 mol of H_2.

∴ Number of moles of N_2 present originally

= 2 + 1 = 3 mol

Number of moles of H_2 present originally

= 2 + 3 = 5 mol

OR

(i) In the reaction, $2A + 4B \rightarrow 3C + 4D$

(a) 2 moles of *A* react with 4 moles of *B*

5 moles of *A* will react with $\frac{4}{2} \times 5 = 10$ moles of *B*

Since in the reaction only 6 moles of *B* are there, hence *B* is the limiting reagent.

(b) 4 moles of *B* give 3 moles of *C*

6 moles of *B* will give $\frac{3}{4} \times 6 = 4.5$ moles of *C*

(ii) 16 mL of CH_3OH is dissolved in 100 mL of solution.

Volume or mass of $H_2O = 100 - 16 = 84$ mL or 84 g

$(\because\ d_{H_2O} \approx 1\ g\ mL^{-1})$

Mass of solution = $V_{sol} \times d_{sol} = 100 \times 0.9 = 90$ g

Mass of solute $(w_2) = w_{sol} - w_1 = 90 - 84 = 6$ g

Molar mass of $CH_3OH = 32\ g\ mol^{-1}$

$$\therefore \quad M = \frac{w_2 \times 1000}{M_2 \times V_{sol}} = \frac{6\times1000}{32\times100} = 1.875\ M$$

$$m = \frac{w_2 \times 1000}{M_2 \times w_1} = \frac{6\times1000}{32\times84} = 2.232\ m$$

CBSE warm-up! CLASS-XII

Chapterwise practice questions for CBSE Exams as per the latest pattern and reduced syllabus by CBSE for the academic session 2022-23.

Series-3

Chemical Kinetics

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

General Instructions : Read the following instructions carefully.

(a) There are 33 questions in this question paper. All questions are compulsory.
(b) Section A : Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
(c) Section B : Q. No. 17 to 25 are short answer questions and carry 2 marks each.
(d) Section C : Q. No. 26 to 30 are short answer questions and carry 3 marks each.
(e) Section D : Q. No. 31 to 33 are long answer questions carrying 5 marks each.
(f) There is no overall choice. However, internal choices have been provided.
(g) Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

Read the passage given below and answer the following questions :

1. Few facts about rate constant are given below :

- Rate of reaction is proportional to rate constant. Greater the value of rate constant, faster is the reaction.
- Value of rate constant is definite for a reaction at a particular temperature. With the change of temperature, rate constant also changes.
- The value of rate constant is independent of concentration of reactants.
- Units of rate constant depend upon the order of reaction.
- Presence of catalyst changes the rate of reaction and thus rate constant as well, by lowering the activation energy.

Units of Rate Constant for a reaction of n^{th} order can be determine as,

$$\text{Rate} = \frac{dx}{dt} = k[\text{concentration}]^n$$

$$k = \frac{dx}{dt} \times \frac{1}{[\text{concentration}]^n}$$

$$= \frac{\text{concentration}}{\text{time}} \times \frac{1}{[\text{concentration}]^n}$$

$$\boxed{k = (\text{concentration})^{1-n}\,\text{time}^{-1}}$$

The following questions are multiple choice questions. Choose the most appropriate answer.

(i) Rate constant in case of first order reaction is
(a) inversely proportional to the concentration units
(b) independent of concentration units
(c) directly proportional to concentration units
(d) inversely proportional to the square of concentration units.

(ii) If the concentrations are expressed in mol litre^{-1} and time in s, then the units of the rate constant of the first order reaction are,

(a) mol litre^{-1} s^{-1} (b) mol^{-1} litre s^{-1}
(c) s^{-1} (d) mol^2 litre^{-2} s^{-1}

(iii) The units for the rate constant for the second order reaction (concentration : mol litre^{-1}, time : s) are
(a) mol^{-1} litre s^{-1} (b) mol litre^{-2} s^{-1}
(c) s^{-1} (d) mol litre^{-1} s^{-1}

OR

Consider the reaction, $2A + B \rightarrow$ products. When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is
(a) s^{-1} (b) L mol^{-1} s^{-1}
(c) no unit (d) mol L^{-1} s^{-1}

(iv) The rate of reaction
$Cl_3CCHO + NO \rightarrow CHCl_3 + NO + CO$ is given by equation, Rate = $k[Cl_3CCHO][NO]$.
If concentration is expressed in moles/litre, the units of k are
(a) litre^2 mole^{-2} sec^{-1} (b) mole litre^{-1} sec^{-1}
(c) litre mole^{-1} sec^{-1} (d) sec^{-1}

Read the passage given below and answer the following questions :

2. In 1889 Arrhenius recognized the temperature dependence of rates or rate constant. He has given an empirical relation, which can be written as
$k = Ae^{-E_a/RT}$
where k is the rate constant (of any order other than zero order), A is the pre-exponential factor, E_a is the activation energy, R is the universal gas constant and T is the absolute temperature.
Activation energy (E_a) is the minimum energy required by a reactant at a certain temperature to undergo transformation into product. Arrhenius clearly assumed that reactions occur because of collisions between atoms and molecules of the reactant. He assumed the activation energy to be the least value of energy which the colliding molecules must possess for the collision to yield a product.
The difference between the energies of the reactant and the transition state (TS) is called E_{af}.
$\Delta H = E_{ar} - E_{af}$
In these questions, Q. No. (i)-(iv), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.
(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

(i) Assertion : If the activation energy of a reaction is zero, the rate constant becomes independent of the temperature.
Reason : Lower the activation energy, faster is the reaction.

(ii) Assertion : The addition of catalyst lowers the activation barrier, yet there is no change in the enthalpy change.
Reason : Enthalpy change is equal to the difference in the activation energies for the forward and the backward reactions.

OR

Assertion : The presence of a catalyst increases the speed of the forward and backward reaction to the same extent.
Reason : Activation energy for both the forward and backward reactions is lowered to the same extent.

(iii) Assertion : Formation of activated complex by reactant molecules is called as transition state.
Reason : Transition state is the configuration of atoms in the activated complex, which if attained leads to the formation of the products.

(iv) Assertion : Order of the reaction can be zero or fractional.
Reason : We cannot determine order from balanced chemical equation.

Following questions (Q. No. 3-11) are multiple choice questions carrying 1 mark each :

3. A following mechanism has been proposed for a reaction : $2A + B \rightarrow D + E$; $A + B \rightarrow C + D$ (slow)
$A + C \rightarrow E$ (fast)
The rate law expression for the reaction is
(a) $r = k\,[A]^2[B]$ (b) $r = k\,[A]\,[B]$
(c) $r = k\,[A]^2$ (d) $r = k\,[A]\,[C]$

4. During the course of a chemical reaction, the rate of a reaction
(a) remains constant throughout
(b) increases as the reaction proceeds
(c) decreases as the reaction proceeds
(d) first increases followed by a decrease.

OR

Half-life period of 2nd order reaction is

(a) proportional to initial concentration of reactants
(b) independent of initial concentration of reactants
(c) inversely proportional to initial concentration of reactants
(d) inversely proportional to square of initial concentration of reactants.

5. The rate equation for the reaction $2A + B \rightarrow C$ is found to be : rate = $k[A][B]$. The correct statement in relation to this reaction is that the

(a) rate of formation of C is twice the rate of disappearance of A
(b) $t_{1/2}$ is a constant
(c) unit of k must be s^{-1}
(d) value of k is independent on the initial concentrations of A and B

OR

The reaction $A \rightarrow B$ follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 hour. What is the time taken for conversion of 0.9 mole of A to produce 0.675 mole of B?

(a) 2 hours (b) 1 hour
(c) 0.5 hour (d) 0.25 hour

6. On increasing the temperature by 10 K the rate of reaction becomes double. Which of the following is the most appropriate reason?

(a) With increase of temperature, velocities increase and hence the number of collisions is appreciably increased.
(b) The activation energy decreases with increase of temperature.
(c) The bonds between the atoms of the reacting molecules become weak at higher temperature.
(d) Higher the temperature, larger is the fraction of colliding particles which can cross the energy barrier.

7. The value of rate constant of a pseudo first order reaction

(a) depends on the concentration of reactants present in small amount
(b) depends on the concentration of reactants present in excess
(c) is independent of the concentration of reactants
(d) depends only on temperature.

8. The temperature dependence of rate constant (k) of a chemical reaction is written in terms of Arrhenius equation, $k = Ae^{-E_a^\circ/RT}$. Activation energy (E_a°) of the reaction can be calculated by plotting

(a) $\log k$ vs $\frac{1}{\log T}$ (b) k vs T
(c) k vs $\frac{1}{\log T}$ (d) $\log k$ vs $\frac{1}{T}$

OR

The rate constant is given by the equation $k = p \cdot Ze^{-E/RT}$. Which factor should register a decrease for the reaction to proceed more rapidly?

(a) T (b) Z (c) E (d) p

9. Consider following reactant samples :

I. 1 mol of A and 1 mol of B in a 1 L vessel
II. 2 mol of A and 2 mol of B in a 2 L vessel
III. 0.2 mol of A and 0.2 mol of B in a 0.1 L vessel

Which of the reactant sample reacts at the highest rate?

(a) I (b) II
(c) III (d) All react at equal rate

10. If n_A and n_B are the number of moles at any instant in the reaction : $2A(g) \rightarrow 3B(g)$ carried out in a vessel of V L, the rate of the reaction at that instant is given by

(a) $-\frac{1}{2}\frac{dn_A}{dt} = \frac{1}{3}\frac{dn_B}{dt}$ (b) $-\frac{1}{V}\frac{dn_A}{dt} = \frac{1}{V}\frac{dn_B}{dt}$
(c) $-\frac{1}{2V}\frac{dn_A}{dt} = \frac{1}{3V}\frac{dn_B}{dt}$ (d) $-\frac{1}{V}\frac{n_A}{t} = \frac{1}{V}\frac{n_B}{t}$

OR

Which of the following rate laws has an overall order of 0.5 for reaction involving substances x, y and z?

(a) Rate = $k(C_x)(C_y)(C_z)$
(b) Rate = $k(C_x)^{0.5}(C_y)^{0.5}(C_z)^{0.5}$
(c) Rate = $k(C_x)^{1.5}(C_y)^{-1}(C_z)^0$
(d) Rate = $k(C_x)(C_z)^2/(C_y)^2$

11. Which of these does not influence the rate of reaction?

(a) Nature of the reactants
(b) Concentration of the reactants
(c) Temperature of the reaction
(d) Molecularity of the reaction

In the following questions (Q. No. 12 - 16) a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

12. **Assertion :** Assuming the elementary reaction to occur through molecular collisions, molecularity of a reaction is defined as the number of atoms or molecules which collide together for reaction to occur.

Reason : The sum of powers of the concentration of the reactants in the rate law expression is called the order of the chemical reaction.

13. **Assertion :** The enthalpy of reaction remains constant in the presence of a catalyst.

Reason : A catalyst participating in the reaction, forms different activated complex and lowers down the activation energy but the difference in energy of reactant and product remains the same.

14. **Assertion :** A complex reaction has molecularity equal to the order of that reaction.

Reason : Molecularity has no meaning for a complex reaction.

OR

Assertion : The rate of inversion of sucrose is monitored with the help of polarimeter (determination of optical rotation at different intervals of time).

Reason : The inversion of sucrose follows the first order kinetics.

15. **Assertion :** In rate law, unlike in the expression for equilibrium constants, the exponents for concentrations do not necessarily match the stoichiometric coefficients.

Reason : It is the mechanism and not the balanced chemical equation for the overall change that governs the reaction rate.

16. **Assertion :** The reactions $2NO + O_2 \rightarrow 2NO_2$ and $2CO + O_2 \rightarrow 2CO_2$ proceed at the same rate because they are similar.

Reason : Reactions having the same activation energies, proceed at same rate.

SECTION - B

The following questions, (Q. No. 17-25) are short answer type and carry 2 marks each.

17. In the formation of sulphur trioxide by contact process, $2SO_2 + O_2 \longrightarrow 2SO_3$, the rate of reaction was measured as $-\frac{d[O_2]}{dt} = 2.5\times10^{-4}$ mol L^{-1} s^{-1}.

What will be the rate of reaction expressed in terms of SO_3 ?

OR

In a chemical reaction $2P \rightarrow 4Q + R$, the concentration of Q is found to be increased by 2.0×10^{-2} mol L^{-1} in five seconds. Calculate

(i) rate of appearance of Q

(ii) rate of reaction.

18. Write the expression for $3/4^{th}$ life of a first order reaction.

19. How can the rate of simple reaction, $2NO + O_2 \rightarrow 2NO_2$, be affected, if volume of the reaction vessel is doubled?

OR

Temperature coefficient for the saponification of an ester by NaOH is 1.75. Calculate the activation energy.

20. For the reaction

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$$

Write:

(i) Rate of reaction expression,

(ii) Rate law equation,

(iii) Molecularity,

(iv) Order of reaction.

OR

How does a change in temperature affect the rate of a reaction? How can this effect on the rate constant of reaction be represented quantitatively?

21. Consider the decomposition of hydrogen peroxide in alkaline medium which is catalysed by iodide ions.

$$2H_2O_2 \xrightarrow{OH^-/I^-} 2H_2O + O_2$$

This reaction takes place in two steps as given below:

Step - I $\quad H_2O_2 + I^- \longrightarrow H_2O + IO^-$ (slow)

Step - II $\quad H_2O_2 + IO^- \longrightarrow H_2O + I^- + O_2$ (fast)

(a) Write the rate law expression and determine the order of reaction w.r.t. H_2O_2.

(b) What is the molecularity of each individual step?

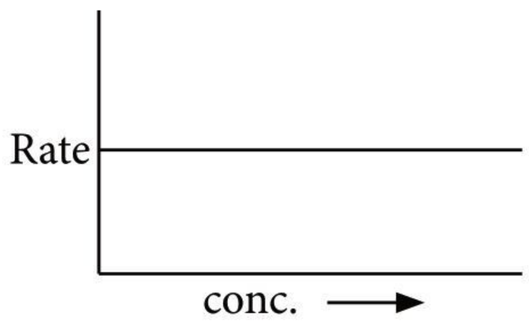
22. At a certain temperature the half life period for the catalytic decomposition of ammonia were found as follows :

Pressure (Pascals) :	6667	13333	26666
Half life period in hours	3.52	1.92	1.0

Calculate the order of reaction.

23. Hydrogenation of vegetable ghee at 25°C reduces the pressure of H_2 from 2 atm to 1.2 atm in 50 min. Calculate the rate of reaction in terms of change of (a) pressure per minute, and (b) molarity per second.

24. For a chemical reaction variation in rate with conc. is shown:



(a) What is the order of the reaction?

(b) What are the units of rate constant k for the reaction?

25. The rate constant for the first order decomposition of a certain reaction is described by the equation

$$\log(k) = 14.34 - \frac{1.25 \times 10^4}{T}$$

What is the energy of activation for this reaction?

SECTION - C

Q. No. 26-30 are short answer type II carrying 3 marks each.

26. The reaction $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$ is a first order reaction with $k = 2.2 \times 10^{-5}$ sec^{-1} at 320°C. What percentage of SO_2Cl_2 is decomposed on heating this gas for 90 minutes ?

OR

The activation energy of a reaction is 75.2 kJ mol^{-1} in the absence of a catalyst and 50.14 kJ mol^{-1} with a catalyst. How many times will the rate of reaction grow is the presence of the catalyst if the reaction proceeds at 25°C? ($R = 8.314$ JK^{-1} mol^{-1})

27. For the reaction $A + B \longrightarrow C$, the following data were obtained. In the first experiment, when the initial concentrations of both A and B are 0.1 M, the observed initial rate of formation of C is 1×10^{-4} mol $litre^{-1}$ min^{-1}. In second experiment when initial concentrations of A and B are 0.1 M and 0.3 M, the initial rate is 9.0×10^{-4} mol $litre^{-1}$ min^{-1}. In the third experiment when initial concentrations of A and B are 0.3 M, the initial rate is 2.7×10^{-3} mol $litre^{-1}$ min^{-1}. Write the rate law and calculate the specific rate constant for this reaction.

OR

The decomposition of N_2O_5 takes place according to the equation :

$2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$

and it is a first order reaction. After 30 min. from the start of decomposition in a closed vessel, the total pressure developed is found to be 284.5 mm Hg and on complete decomposition, the total pressure is 584.5 mm Hg. Calculate the rate constant of the reaction.

28. **(a)** Why can't molecularity of any reaction be equal to zero?

(b) Why molecularly is applicable only for elementary reactions and order is applicable for elementary as well as complex reactions ?

29. For a decomposition reaction, the values of k at two different temperatures are given below:

$k_1 = 2.15 \times 10^{-8}$ L/(mol.s) at 650 K

$k_2 = 2.39 \times 10^{-8}$ L/(mol.s) at 700 K

Calculate the value of E_a for the reaction.

($R = 8.314$ J K^{-1} mol^{-1})

30. The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume :

$SO_2Cl_{2(g)} \longrightarrow SO_{2(g)} + Cl_{2(g)}$

Experiment	Time/s	Total pressure/atm
1	0	0.4
2	100	0.7

Calculate the rate constant.

(Given : log 4 = 0.6021, log 2 = 0.3010)

SECTION - D

Q. No. 31-33 are long answer type carrying 5 marks each.

31. **(a)** Draw the plot of ln k *vs* $1/T$ for a chemical reaction. What does the intercept represent? What is the relation between slope and E_a?

(b) The velocity constant of the decomposition of hydrogen iodide at 283°C and 508°C are 3.517×10^{-7} and 3.954×10^{-2} respectively. Calculate the frequency factor at 283°C and energy of activation of reaction.

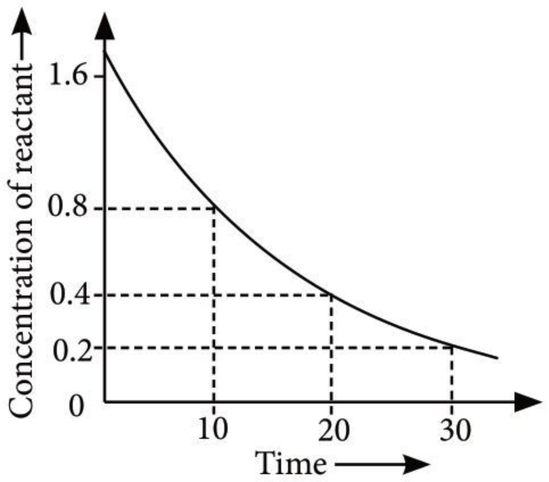
OR

(a) Can activation energy for reactions be zero?

(b) In the Arrhenius equation for a certain reaction values of A and E_a are 4×10^{13} s^{-1} and 98.6 KJ mol^{-1} respectively. If the reaction is of

first order, then at what temperature will its half life period be 10 min?

32. (i) Analyse the given graph, drawn between concentration of reactant *vs.* time.



(a) Predict the order of reaction.

(b) What is molecularity of a reaction?

(ii) A reaction is first order in *A* and second order in *B*.

(a) Write differential rate equation.

(b) How is rate affected when concentration of *B* is tripled?

(c) How is rate affected when concentration of both *A* and *B* is doubled?

(iii) What is molecularity of a reaction?

OR

(a) What is the physical significance of energy of activation?

(b) In general, it is observed that the rate of a chemical reaction doubles with every 10 degree rise in temperature. If the generalisation holds good for the reaction in the temperature range of 295 K to 305 K, what would be the value of activation energy for this reaction?
[$R = 8.314\ J/K^{-1}\ mol^{-1}$]

33. (i) The rate law for a reaction is
Rate = $k\ [A][B]^{3/2}$
Can the reaction be an elementary process? Explain.

(ii) In a reaction between *A* and *B*, the initial rate of reaction (r_0) was measured for different initial concentrations of A and B as given below :

***A*/mol L^{-1}**	0.20	0.20	0.40
***B*/mol L^{-1}**	0.30	0.10	0.05
r_0/mol L^{-1} s^{-1}	5.07×10^{-5}	5.07×10^{-5}	1.43×10^{-4}

What is the order of the reaction with respect to a and B ?

OR

(i) Will the rate constant of the reaction depend upon *T* if the E_{act} (activation energy) of the reaction is zero?

(ii) In a first order reaction, the concentration of the reactant is reduced from 0.6 mol L^{-1} to 0.2 mol L^{-1} in 5 minutes. Calculate the rate constant of the reaction.

(iii) For a reaction : $2NH_{3(g)} \xrightarrow{Pt} N_{2(g)} + 3H_{2(g)}$; Rate = *k*

(a) Write the order and molecularity of this reaction.

(b) Write the unit of *k*.

SOLUTIONS

1. (i)(b) : In case of first order reaction
rate constant (k) = sec^{-1}

(ii) (c) : mol L^{-1} s^{-1} = k (mol L^{-1})
$\therefore$ units of k is s^{-1}.

(iii)(a) : Rate = $k[A]^2$

$$\frac{\text{mol litre}^{-1}}{\text{s}} = k\ (\text{mol litre}^{-1})^2$$

$\therefore$ k = mol^{-1} litre s^{-1}

OR

(b) : Rate = $k\ [A]^x\ [B]^y$
When [*B*] is doubled, keeping [*A*] constant, half-life of the reaction does not change.

Now, for a first order reaction $t_{1/2} = \dfrac{0.693}{k}$

i.e., $t_{1/2}$ is independent of the concentration of the reactant. Hence the reaction is first order with respect to *B*. Now when [*A*] is doubled, keeping [*B*] constant, the rate also doubles. Hence the reaction is first order with respect to *A*.

$\therefore$ Rate = $[A]^1\ [B]^1$ $\therefore$ Order = 2.

Now for n^{th} order reaction, unit of rate constant is (litre) $^{n-1}$ $(mol)^{1-n}$ sec^{-1} when n = 2, unit of rate constant is lit mol^{-1} sec^{-1}.

(iv) (c)

2. (i)(b) : $k = Ae^{-E_a/RT}$
$E_a = 0, k = A$

(ii) (a) : For reversible reactions, the energy of activation for the reverse reaction is lowered to the same extent as for the direct reaction. Hence the presence of the catalyst in such reactions increases the speed of the forward reaction and that of the backward reaction

to the same extent. Consequently, the equilibrium is attained quickly but is otherwise not disturbed.

OR

(a) : Catalyst provides a new alternative path of lower activation energy.

(iii)(a) : According to transition state theory, the reactant molecules must come together to form an activated complex, whose energy is higher than the reactant molecules, before the activated complex is converted into product molecules.

(iv) (b)

3. (b) : Slow step is rate determining step hence,
Rate = $k\,[A][B]$

4. (c) : Rate of reaction $\propto$ concentration of reactants
As the reaction proceeds, concentration of reactant decreases and so rate of reaction also decreases.

OR

(c) : For n^{th} order reaction, $t_{1/2} \propto [A_0]^{1-n}$

For 2^{nd} order, $t_{1/2} \propto [A_0]^{-1}$ *i.e.*, $t_{1/2} \propto \dfrac{1}{[A_0]}$.

5. (d) : The rate constant depends on temperature only. It is independent of concentration of reactants.

OR

(b) : $A \rightarrow B$ For a first order reaction

$$k = \frac{2.303}{t}\log\left(\frac{a}{a-x}\right)$$

Given $a = 0.8$ mol, $(a - x) = 0.8 - 0.6 = 0.2$

$$k = \frac{2.303}{1}\log\left(\frac{0.8}{0.2}\right) \text{ or } k = 2.303 \log 4$$

again $a = 0.9$, $a - x = 0.9 - 0.675 = 0.225$

$$k = \frac{2.303}{t}\log\left(\frac{0.9}{0.225}\right);\ 2.303\log 4 = \frac{2.303}{t}\log 4$$

Hence $t = 1$ hour

6. (d) **7. (b)**

8. (d): $\log k = \log A - \dfrac{E_a}{2.303\,RT}$

Thus a plot of $\log k$ vs $1/T$ should be a straight line with slope equal to $-E_a/2.303\,R$ and intercept equal to $\log A$.

$\therefore$ Slope $= \dfrac{-E_a}{2.303R}$

or $E_a = -2.303R \times$ Slope

OR

(c) : Lower the activation energy, faster is the reaction.

9. (c) : Vessel III has highest concentration of reactants,

$$c = \frac{n}{V} = \frac{0.2}{0.1} = 2 \text{ mol/L} \text{ (for each reactant)}$$

Higher the concentration of reactants higher is the rate of reaction.

10. (c)

OR

(c) : Order of reaction = 1.5 – 1 + 0 = 0.5

11. (d) **12. (b)** **13. (a)**

14. (d) : Complex reaction proceeds in more than one step (elementary reaction). Molecularity is the characteristic of elementary reactions but not of the overall reaction.

OR

(b) : The rate of inversion is monitored by polarimetry because sucrose (reactant) and glucose and fructose (products) are optically active.

15. (a)

16. (d) : The given reactions proceed at different rates.

17. Rate of reaction $= -\dfrac{1}{2}\dfrac{d[SO_2]}{dt} = -\dfrac{d[O_2]}{dt} = \dfrac{1}{2}\dfrac{d[SO_3]}{dt}$

Since $-\dfrac{d[O_2]}{dt} = 2.5\times10^{-4} = \dfrac{1}{2}\dfrac{d[SO_3]}{dt}$

$\dfrac{d[SO_3]}{dt} = 5\times10^{-4}$ mol L^{-1} s^{-1}

OR

(i) Rate of appearance of Q

$$\frac{d[Q]}{dt} = \frac{2\times10^{-2}}{5} = 0.4\times10^{-2} \text{ mol } L^{-1} \text{ } s^{-1}$$

(ii) Rate of reaction

$$\frac{1}{4}\frac{d[Q]}{dt} = \frac{1}{4}\times0.4\times10^{-2} = 10^{-3} \text{ mol } L^{-1} \text{ } s^{-1}$$

The reciprocals of coefficients are written for the expression of rate of reaction.

18. Putting $x = \dfrac{3}{4}a$ and $a - x = \dfrac{a}{4}$ in the integrated equation of first order, we get

$$t_{3/4} = \frac{2.303}{k}\log\left(\frac{a}{a-\frac{3a}{4}}\right) = \frac{2.303}{k}\log 4 = \frac{1.386}{k}$$

19. Rate $(r_1) = k\,[NO]_2[O_2]$

If volume of reaction vessel is doubled, the concentration of reactants becomes half, then,

Rate $(r_2) = k\left[\dfrac{1}{2}NO\right]^2\left[\dfrac{1}{2}O_2\right]$

$$= \frac{1}{4} \times \frac{1}{2} k[NO]^2[O_2] = \frac{1}{8} r_1$$

i.e., rate becomes $\left(\frac{1}{8}\right)^{th}$ of the initial rate.

OR

Temperature coefficient *i.e.*, $\frac{k_2}{k_1} = 1.75$

In general practice T_1 is taken as 25°C *i.e.*, 298 K and T_2 as 35°C *i.e.*, 308 K.

Thus, $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$

$$\log 1.75 = \frac{E_a}{2.303 \times 1.987} \times \left[\frac{10}{308 \times 298}\right]$$

E_a = 10.207 kcal mol^{-1}

20. (i) Rate = $-\frac{d[C_{12}H_{22}O_{11}]}{dt} = \frac{-d[H_2O]}{dt}$

$$= \frac{d[C_6H_{12}O_6]}{dt} = \frac{d[C_6H_{12}O_6]}{dt}$$

(ii) Rate law equation : Rate = $k[C_{12}H_{22}O_{11}]$

(iii) Molecularity = 2

(iv) Order = 1

OR

The rate of reaction is nearly doubled with a rise in temperature by 10° for a chemical reaction. The temperature effect on the rate constant can be represented quantitatively by Arrherius equation :

$$k = Ae^{-E_a/RT}$$

where $k \rightarrow$ Rate constant

$A \rightarrow$ Arrhenius factor

$R \rightarrow$ Gas constant

$T \rightarrow$ Temperature

$E_a \rightarrow$ Energy of activation for the reaction.

21. (a) Rate = $k[H_2O_2][I^-]$; Order w.r.t. H_2O_2 = 1

(b) Molecularity : Step I = 2, Step II = 2

22. $\left\{\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{a_2}{a_1}\right)^{n-1}\right\}$ where n is the order of reaction.

From the given data, $\frac{3.52}{1.92} = \left(\frac{13333}{6667}\right)^{n-1} = (2)^{n-1}$

($\therefore$ $a \propto$ initial pressure)

$$\log\left(\frac{3.52}{1.92}\right) = (n-1)\log 2 = 0.3010 \times (n-1)$$

$0.2632 = 0.3010 \times (n - 1)$

$n = 1.87 = 2$

23. Rate of reaction = $\frac{\text{Change in pressure}}{\text{time}} = \frac{2 - 1.2}{50}$

$= \frac{0.8}{50} = 1.6 \times 10^{-2}$ atm min^{-1}

Change in molarity can be derived from:

$PV = nRT$; $\frac{n}{V} = \frac{P}{RT}$ or $\frac{n}{V} = \frac{0.8}{0.0821 \times 298} = 0.327$

Rate of reaction = $\frac{\text{Change in molarity}}{\text{time in second}} = \frac{0.327}{50 \times 60}$

$= 1.09 \times 10^{-5}$ mol litre^{-1} sec^{-1}

24. (a) Order of reaction is zero.

(b) Units of rate constant is mol L^{-1} s^{-1}.

25. We know $k = A.e^{-E_a/RT}$ or $\log k = \log A - \frac{E_a}{2.303\,RT}$

Comparing this equation with the given equation, we get, $\frac{E_a}{2.303R} = 1.25 \times 10^4$

Hence $E_a = 1.25 \times 10^4 \times 2.303 \times 8.314$

$= 2.39 \times 10^5$ J mol^{-1} or 239 kJ mol^{-1}

26. $k = \frac{2.303}{t}\log\frac{a}{(a-x)}$

$$\log\frac{a}{(a-x)} = \frac{2.2 \times 10^{-5} \times 90 \times 60}{2.303} = 0.05158$$

(t = 90 minutes = 90 × 60 seconds)

taking antilog, $\frac{a}{(a-x)} = 1.126$

$\frac{(a-x)}{a} = 0.888$

$\frac{(a-x)}{a}$ gives the fraction of reactant left after a time span of t.

$\therefore$ Percentage of reactant left = 88.8 %

Thus, reactant decomposed = 100 – 88.8 = 11.2 %.

OR

According to the Arrhenius equations.

$$\log k = \log A - \frac{E_a}{2.303RT}$$

For uncatalysed reaction,

$$\log k_1 = \log A - \frac{E_a(1)}{2.303RT} \quad \text{...(i)}$$

For catalysed reaction,

$$\log k_2 = \log A - \frac{E_a(2)}{2.303RT} \quad \text{...(ii)}$$

A is equal for the same reaction.

Subtracting Eqn. (i) from Eqn. (ii)

$$\log\frac{k_2}{k_1}=\frac{E_a(1)-E_a(2)}{2.303RT}=\frac{(75.2-50.14)\times10^3\ \text{J mol}^{-1}}{2.303\times8.314\times298}$$

$$\log\frac{k_2}{k_1}=4.39\ ;\ \frac{k_2}{k_1}=2.45\times10^4$$

$\therefore$ Rate of reaction increases by 2.45×10^4 times.

27. Rate $= k[A]^m\,[B]^n$

Given: $r_1 = 1\times10^{-4} = k\,[0.1]^m\,[0.1]^n$ ...(i)

$r_2 = 9\times10^{-4} = k[0.1]^m\,[0.3]^n$ ...(ii)

$r_3 = 2.7\times10^{-3} = k[0.3]^m\,[0.3]^n$ ...(iii)

From Eqs (i) and (ii); $\frac{r_1}{r_2}=\frac{1\times10^{-4}}{9\times10^{-4}}=\left[\frac{1}{3}\right]^n \Rightarrow n=2$

From Eqs. (ii) and (iii); $\frac{r_2}{r_3}=\frac{9\times10^{-4}}{2.7\times10^{-3}}=\left[\frac{1}{3}\right]^m \Rightarrow m=1$

Rate $= k[A]^1\,[B]^2$

Using Eq. (i), $1\times10^{-4} = k[0.1]^1\,[0.1]^2$

$\therefore\ k = 10^{-1} = 0.1$ litre^2 mol^{-2} min^{-1}

OR

$2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$

2 mol of N_2O_5 (g) on decomposition gives a total of 5 mol of gaseous species (4 mol NO_2 and 1 mol O_2). Hence, pressure of N_2O_5 to start with is given as

$$p_0 = 584.5\times\frac{2}{5} = 233.8\ \text{mm Hg}$$

Now, the partial pressure of N_2O_5 after 30 min would be given as

$$p_t + (233.8 - p_t)\times\frac{5}{2} = 284.5$$

$p_t = 200$ mm Hg

Now using the expression

$$\log\frac{p_t}{p_0} = -\frac{k}{2.303}t \quad \text{or} \quad \log\frac{200}{233.8} = -\frac{k}{2.303}\times30$$

$$\text{k} = -\frac{2.303}{30}\log\frac{200}{233.8} = 5.21\times10^{-3}\ \text{min}^{-1}$$

28. (a) Molecularity is the number of molecules taking part in an elementary step. For this we require at least a single molecule leading to the value of minimum molecularity of one.

(b) A complex reaction occurs through several elementary reactions. Numbers of molecules involved in each elementary reaction may be different i.e., the molecularity of each step may be different. Therefore, the moleuclarity of overall complex reaction is meaningless. On the other hand, order of complex reaction is experimentally determined by the slowest step in its mechanism and is therefore, applicable even in the case of complex reactions.

29. $\log\frac{k_2}{k_1}=\frac{E_a}{2.303R}\left(\frac{T_2-T_1}{T_1T_2}\right)$

$$E_a=\left(\frac{2.303\times R\times T_1\times T_2}{T_2-T_1}\right)\log\frac{k_2}{k_1}$$

$$E_a=\frac{2.303\times8.314\,\text{J mol}^{-1}\,\text{K}^{-1}\times650\,\text{K}\times700\,\text{K}}{700\,\text{K}-650\,\text{K}}$$

$$\times\log\frac{2.39\times10^{-8}}{2.15\times10^{-8}}$$

$$E_a=\frac{19.147\times650\times700}{50}(\log2.39-\log2.15)\ \text{J mol}^{-1}$$

$= 174237.7\ (0.3783 - 0.3324)$ J mol^{-1}

$= 174237.7\times0.0459$ J mol^{-1} $= 7997.51$ J mol^{-1}

30. The given reaction is

	$SO_2Cl_{2(g)}$	$\longrightarrow$	$SO_{2(g)}$ +	$Cl_{2(g)}$
At $t=0$	0.4 atm		0	0
At time t	$(0.4-x)$ atm		x atm	x atm

Total pressure at time t will be

$P_T = (0.4 - x) + x + x = 0.4 + x$

$x = (P_T - 0.4)$

Pressure of SO_2Cl_2 at time t will be

$p_{SO_2Cl_2} = 0.4 - x = 0.4 - (P_T - 0.4) = 0.8 - P_T$

At time $t = 100$ s, $P_T = 0.7$ atm

$\therefore\ p_{SO_2Cl_2} = 0.8 - 0.7 = 0.1$ atm

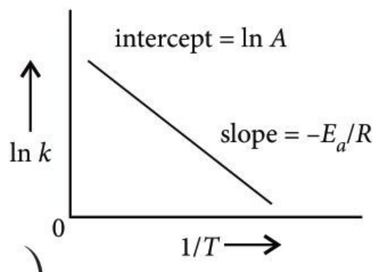
According to first order kinetic equation

$$k=\frac{2.303}{t}\log\left(\frac{p_{SO_2Cl_2\,(\text{initial})}}{p_{SO_2Cl_2\,(\text{after reaction})}}\right)$$

$$=\frac{2.303}{100}\log\left(\frac{0.4}{0.1}\right)=1.3\times10^{-2}\ \text{s}^{-1}$$

31. (a) $\ln k=-\frac{E_a}{RT}+\ln A$

Intercept $= \ln A$



(b) We know that,

(i) $E_a=\frac{2.303\times R\times T_1\times T_2}{T_2-T_1}\log\left(\frac{k_2}{k_1}\right)$

$$=\frac{2.303\times2\times556\times781}{781-556}\log\left(\frac{3.954\times10^2}{3.517\times10^{-7}}\right)$$

By usual calculation, $E_a = 44898$ cal

(ii) Again we know that, $k = Ae^{-E_a/RT}$

Substituting the values of k, E_a, R and T

$3.517 \times 10^{-7} = A.e^{-44898/2 \times 556}$

$$\log 3.517 \times 10^{-7} = \log A - \frac{44898}{2 \times 556}$$

$\log A = -6.4538 + 40.376$

$A = 8.36 \times 10^{33}$

OR

(a) In the Arrhenius equation,

$k = Ae^{-E_a/RT}$

If E_a is zero then $k = A$

i.e., every collision between molecules leads to the chemical reaction. This is not true. Thus, E_a cannot be zero.

(b) According to Arrhenius equation,

$k = Ae^{-E_a/RT}$

or $\log \frac{k}{A} = -\frac{E_a}{RT} \times \frac{1}{2.303}$

Calculation of k

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{10 \times 60} = 1.155 \times 10^{-3}$$

$$\therefore \quad \log\left(\frac{1.155 \times 10^{-3}}{4 \times 10^{13}}\right) = -\frac{98.6 \times 10^{3}}{8.34 \times T \times 2.303}$$

or $-16.54 = -\frac{98600}{8.314 \times 2.303\, T}$

or $T = \frac{98600}{8.314 \times 2.303 \times 16.54} = 311.3\ \text{K}$

32. (i) (a) The reaction is of first order.

(b) Molecularity of a reaction is the number of reacting particles which collide simultaneously to bring about the chemical change. It is a theoretical concept.

(ii) (a) Differential rate equation of reaction is

$$\frac{dx}{dt} = k[A]^1[B]^2 = k[A][B]^2$$

(b) When conc. of B is tripled, it means conc. of B becomes $[3B]$

$\therefore$ New rate of reaction, $\frac{dx'}{dt} = k[A][3B]^2$

$= 9k[A][B]^2$

i.e., the rate of reaction will become 9 times.

(c) When conc. of A is doubled and that of B is also doubled, then conc. of A becomes $[2A]$ and that of B becomes $[2B]$.

$\therefore$ Now rate of reaction, $\frac{dx'}{dt} = k[2A][2B]^2 = 8k\,[A][B]^2$

i.e., the rate of reaction will become 8 times.

(iii) Molecularity of a reaction is the number of reacting particles which collide simultaneously to bring about the chemical change. It is a theoretical concept.

OR

(a) The energy required to form activated complex is called activation energy.

It is the difference between the threshold energy and the average energy possessed by the reacting molecules.

(b) $T_1 = 295$ K, $k_1 = k$ (say)

$T_2 = 305$ K, $k_2 = 2k$, $E_a = ?$

Using Arrhenius equation,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303\ R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$\log \frac{2k}{k} = \frac{E_a}{2.303 \times 8.314} \times \frac{305 - 295}{295 \times 305}$$

$$E_a = \frac{2.303 \times 8.314 \times 295 \times 305 \times \log 2}{10}$$

$$= \frac{2.303 \times 8.314 \times 295 \times 305 \times 0.3010}{10}$$

$= 51855.2\ \text{J mol}^{-1}$

33. (i) No, an elementary process would have a rate law order equal to its molecularity and therefore, must be integers.

(ii) Rate $= k[A]^p\,[B]^q$

$\text{Rate}_1 = (0.20)^p\,(0.30)^q = 5.07 \times 10^{-5}$ ...(i)

$\text{Rate}_2 = (0.20)^p\,(0.10)^q = 5.07 \times 10^{-5}$ ...(ii)

$$\frac{(\text{Rate})_1}{(\text{Rate})_2} = \frac{(0.30)^q}{(0.10)^q} = 1$$

$3^q = 1$ or $3^q = 3^0$ $\therefore$ q = 0

$\text{Rate}_3 = (0.40)\text{p}\ (0.05)\text{q} = 1.43 \times 10^{-4}$ ...(iii)

Dividing (iii) by (ii)

$$\frac{(\text{Rate})_3}{(\text{Rate})_2} = \frac{(0.40)^p (0.05)^q}{(0.20)^p (0.10)^q} = \frac{1.43 \times 10^{-4}}{5.07 \times 10^{-5}}$$

$2^p \times \frac{1}{2^0} = 2.8\ ;\ 2^p = 2.8$

Since $q = 0$

Taking log on both sides

$p \log 2 = \log 2.8$

or $p = \frac{\log 2.8}{\log 2} = \frac{0.45}{0.3010} = 1.5$

order or reaction w.r.t A = 1.5,
order of reaction w.r.t, B = 0.

OR

(i) No

(ii) $a = 0.6$ mol/L, $(a - x) = 0.4$ mol/L

$t = 5$ min

$$k = \frac{2.303}{5\,\text{min}} \log \frac{0.6}{0.4} = 0.0811\ \text{min}^{-1}$$

(iii)(a) The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.

In this reaction, platinum metal acts as a catalyst. At high pressure, the metal surface gets saturated with gas molecules. So, a further change in reaction conditions is unable to alter the amount of ammonia on the surface of the catalyst making rate of the reaction independent of its concentration.

However, two molecules of ammonia react to give products thus, the molecularity is two.

(b) For a zero order reaction, unit of rate constant is mol L^{-1} s^{-1}.

Scientist In Focus

Asima Chatterjee

Early Life and Education

- Asima Chatterjee was born on September 23rd, 1917 in Calcutta. She was born into a middle-class family which, at the time, meant no education for females. Her father loved Botany, this was where she developed her interest in medicine. But, her particular interest in the field of medicine began with her curiosity regarding the medicinal properties of plants. In 1936, she did her higher studies in chemistry, passing with honors distinction, from the Scottish Church College of the University of Calcutta. There weren't many girls in her class as women were rarely pushed to study more.

Asima Chatterjee
(23 September 1917 - 22 November 2006)

- She graduated, with honours, from the Scottish Church College, University of Calcutta in 1936. She further pursued Masters in Organic Chemistry from the University of Calcutta and obtained the degree in 1938. She did not stop at this and went on to do her D.Sc. at the University of Calcutta. She was the first woman to receive a doctorate at an Indian University in 1944.
- As a doctoral student, she worked on the chemistry of plant products and synthetic organic chemistry with the renowned chemist, Prafulla Chandra Ray (known as the father of Chemical science in India) and Satyendra Nath Bose, the famous physicist. She went on to work with Lásló Zechmeister at University of Wisconsin and Caltech for her post-doctoral research on biologically active alkaloids.

Notable Work

Chatterjee's contributions to science include the following:

- Initiated chemical investigation of alkaloids in Rauwolfia canescens.
- Investigated the chemistry of almost all principal types of indole alkaloids.
- Contributions to the elucidation of the structure and stereochemistry of ajmalicine and sarpagine.
- First suggested stereo-configuration of sarpagine.
- Isolated and characterised geissoschizine, a key precursor in biogenesis of indole alkaloids from Rhazya stricta.
- Carried out synthetic studies on a number of complex indole, quinoline and isoquinoline alkaloids.
- Developed procedures for the preparation of beta-phenylethanolamines in connection with alkaloid synthesis.
- Investigated the mechanism of acid-catalysed hydramine fission of beta phenylethanol amines.
- Introduced the use of periodic acid as a reagent for the detection and location of both terminal and exocyclic double bonds in organic compounds.

Awards and Recognition

- She was a Premchand Roychand Scholar of the University of Calcutta.
- In 1972, she was appointed as the Honorary Coordinator of the Special Assistance Programme to intensify teaching and research in natural product chemistry, sanctioned by the Indian University Grants Commission.
- In 1960, she was elected a Fellow of the Indian National Science Academy, New Delhi.
- In 1961, she received the Shanti Swarup Bhatnagar Award in chemical science, becoming the first female recipient of this award.
- In 1975, she was conferred the Padma Bhushan and became the first female scientist to be elected as the General President of the Indian Science Congress Association.
- She was conferred the D. Sc. (honoris causa) degree by several universities.
- She was nominated by the President of India as a Member of the Rajya Sabha from February 1982 to May 1990.
- On 23 September 2017, the search engine Google deployed a 24-hour Google Doodle in honour of the 100th anniversary of Chatterjee's birth.
- She won the C.V Raman award, P.C Ray Award, and the S.S Bhatnagar award.
- IIT Patna named a girls' hostel after Asima.

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